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The Knowles Steam Pump Co. call our attention to the fact that the late accident to one of their 15,000,000 gallon pumping engines at Cleveland, O., as noted in these columns in our issue of July 27, was really a slight matter and in no way the fault of the engine itself.

Plans for the proposed Genesee River storage dam to be built near Mount Morris by the State of New York are to be prepared by Mr. Geo. W. Rafter, M. Am. Soc. C. E. The dam may be carried to a height of 130 ft., and as the conditions are said to be somewhat unique the structure will probably be a notable one, its height alone giving it prominence among the large dams of the world.

The Waukesha, Wis., controversy over the right of the Waukesha Hygeia Co. to extend its pipe line for the supply of drinking water to the World's Fair into the village of Waukesha was described in our issues of Jan. 12 and March 23, 1893. The final outcome of the affair was that the company finding itself beaten in the courts and legislature, proceeded to take its supply from a spring some ten miles distant from the village of Waukesha. Information regarding the pipe line of the company, as originally proposed and of the attempts to secure the privilege of piping the city of Chicago for the distribution of the water was given in our issues of March 19, 1892, April 27, and May 4, 1893.

In the article on the new water-works pumping machinery at Dallas, Tex., in our issue of July 27, the elevation of the water chambers should have been given as 89, instead of 39 ft. and the elevation of the top of the stand-pipe as 263, instead of 209 ft.

An International Irrigation Congress is to be opened at Los Angeles, Cal., on Oct. 10, for the discussion of irrigation methods, securities and law. The diplomatic officers of the United States have been instructed by Secretary Gresham to informally notify foreign governments of the convention and to request their co-operation through duly accredited delegates.

The interlocking switch and signal plant at the complicated track crossing at Stewart Ave. and 21st St., Chicago, Ill., the plan of which was given in our issue of Sept. 22, 1892, was put in operation on Aug. 6. The plant was put in by the Union Switch & Signal Co., and is to be operated for six months by its operators. Compressed air is the power used, controlled by electric appliances. There are 108 levers 8 ins. long, those in the upper row throwing the switches and those in the lower row the signals. The 50 switch levers throw 13 single switches, 37 crossovers, and 22 switches with movable frogs, making a total of 172 pairs of movable points. One lever alone throws 16 movable points and nearly 500 ft. of detector bars. Forty of the signal levers are in use, operating from one to five signals each, of 85 signals in all. The signals are lighted by electricity. The operating force consists of a train director and a leverman, the latter throwing the levers for the movements dictated by the power, and the force will work in eight-hour shifts. Reference to our plan of this crossing will show the extraordinary complication of the problem to be solved in designing the interlocking plant, particularly as there is a constant train and switching traffic. The cost of the plant was about $150,000.

The most serious railway accident of the week occurred at Lindsey, O., eight miles west of Fremont, O., on the Lake Shore & Michigan Southern Ry., Aug. 5. A local freight train had been sidetracked to await the passing of a westbound express, which left Fremont at 10 o'clock p. m., ten minutes late. The express train was running at full speed and passed safely until the second sleeper neared the switch, close to the freight, when it jumped the track and ran into the engine of the freight. The engine was turned completely around, and this and three sleeping cars were wrecked. The engineer and fireman of the freight train and a porter of the second sleeper were killed and about 25 persons were injured.——A rear end freight collision occurred at midnight Aug. 5 on the bridge that carries the Cleveland, Cincinnati, Chicago & St. Louis Ry. across the north fork of the Vermilion River, at Danville, Ill. An eastbound freight train broke in two parts just after crossing the bridge, and the caboose and five cars ran back onto the bridge. Another eastbound freight train was following, and a collision occurred. The shock knocked one or two spans of the bridge off the piers into the river, 63 ft. below. The engine and 28 cars, comprising the second train, and four cars of the first train went down with the bridge. The damage is estimated at $100,000. One person was killed and several injured.

A highway bridge near Abingdon, Ia., gave way Aug. 4 under a steam threshing machine and two persons were killed.——A highway bridge across the Brazos River, near Richmond, Tex., gave way Aug. 6, carrying down with it 200 head of cattle, 20 horses and two negroes, who were killed.——A highway bridge across the Brazos River, near Calvert, Tex., gave way Aug. 1, killing over 100 head of cattle.——A report from Raleigh, N. C., Aug. 3 states that five spans of a highway bridge over Rockfish Creek, in Cumberland Co., have collapsed, killing one workman and injuring four others who were making repairs.——The bridge on the Phoenixville branch of the Pennsylvania R. R., at the crossing of the Lancaster turnpike, was burned Aug. 5, according to a report from West Chester, Pa. ——The boiler of a farm engine exploded near Newark, O., July 31, killing five persons and injuring four others.

A new steel observatory tower, 300 ft. high, has been erected at Niagara Falls, in Prospect Park. It is provided with two fast-moving elevators. If we are to judge from illustrations published, however, it is not a great success architecturally, whatever advantages it may have in affording a more extended view to sightseers.

Steam shovels, says the Duluth "Herald," are successfully working at stripping the Mesaba ore deposits at the Biwabik mine. The owners of the shovels claim that when in perfect working order they can remove at least 1,000 cu. yds. of material per day at a cost of about 40 cts. per yard. As they claim that the removal of one yard of earth uncovers five tons of ore, the cost per ton of ore is 8 cts.

Tile-faced concrete walls are described in a late issue of "Indian Engineering." In this case the tiles are made L-shaped. Two rows of tiles are laid parallel to each other and the thickness of the wall apart, and the space between, to the tops of the tiles, is filled with concrete. Another row of tiles is laid on each side and the filling repeated, until the wall is high enough. With superior tiles a good, strong wall is the result, with a smooth tile surface.

Electricity as a motive power is to be substituted for steam on the Union Elevated Railway of Brooklyn. The managers of this road say they are forced to do this after competing for many months with the surface trolley lines with steadily increasing loss. Chief Engineer O. F. Nichols says that it has not yet been decided whether the trolley or the storage battery system will be adopted. He has been personally examining the electric locomotives designed for use in the new Baltimore & Ohio tunnel, in Baltimore, and also a system specially designed for elevated roads. The Baltimore engines, first referred to, were built by the General Electric Company, and are of 1,200 HP. each. They will consist of three separate trucks coupled; the weight on driving wheels will be 100 tons, and there will be 12 drivers to each locomotive. These engines are to haul a maximum load of 1,200 tons at a speed of 15 miles per hour; or a passenger train of 500 tons at 30 miles per hour. The current will be supplied by the regular trolley wire with ground return through the rails, with special arrangements at switches and sidings.

A twin-screw Sound steamer, the "City of Lowell," is being built at Bath, Me., for the Norwich line, from the designs of Mr. A. Cary Smith, of New York. This boat will be 320 ft. long on the water line, 336 ft. over all, 40 ft. molded beam, and 66 ft. wide over guards, and 13 ft. loaded draft. Her twin screws will be operated by two triple expansion engines of 4,500 I. HP., with cylinders 26 × 40 ins. and 26 × 60 ins., and 36-in. stroke. The speed expected is about 20 miles per hour.

A contract for 1,000,000 lbs. of steel gun forgings has been awarded by the U. S. Navy Department to the Midvale and the Bethlehem companies.

The rebuilding of the Louisville & Nashville R. R. bridge across the Ohio at Cincinnati will be the subject of a lawsuit between the river men and the railway company. The law requires a channel span of 500 ft., and the one proposed is 418 ft., as claimed by the river men. The piers, too, are said to be lower than required by law.

In the case of the burning of the Cold Storage Building at the World's Columbian Exposition, already noted in our columns, the Grand Jury has acquitted the four persons indicted, viz.: Mr. D. H. Burnham, Director of Works; Mr. Murphy, Fire Marshal, and Mr. Skinner and Mr. McDonald, of the Hercules Iron Works, who had the concession.

The Bureau of American Republics has received from U. S. Consul Plumacher the text of two concessions from the Government of Venezuela for railways from the city of Merida, one to connect with the terminus of the San Carlos road, which was originally destined to reach Merida, and the other to reach the extension of the Ceiba road, now in progress. Should these two contracts be successfully executed, the Merida section of the Cordilliera region would be greatly benefited, and would then have two different branches to Lake Maracaibo by rail, but the engineering, or rather construction, difficulties are said by Mr. Plumacher to be enormous. The contract entered into between the Minister of Public Works, of the first part, and Gen. Solomon Delgado, of the second part, for himself as representing the syndicate formed by Aristides Matute, James A. Scott and Solomon Delgado, provides that within three years a single-track railway shall be built to unite Merida with the station "El Vijia," of the railway from Santa Barbara to "El Vijia," and that within the further term of three years a railway shall be constructed from Merida to Timotes, or to another town of the section Trujillo, where the prolongation of the railway from Sabana de Mendoza to Valera shall terminate. Permission is given for a construction of branch lines. Work upon one or the other railway must commence within one year from approval of contract by the National Congress. No similar concession to other corporations may be granted by the Government during the term of 90 years. The other conditions are favorable.

The embankment of a 20,000,000-gallon distributing reservoir at Portland, Me., failed on Aug. 6, destroying two houses and a barn and causing four deaths. The particulars at hand are not sufficient to show the cause of the failure. The embankment was of clay loam, finished on the inner slope with 6 ft. of clay puddle, then 6 ins. of broken stone and finally 8 ins. of granite block paving. Both slopes were 1½ to 1. A section of the embankment given in the "Manual of American Water-Works" for 1889-90 shows it to have been (presumably at the highest point) 45 ft. high, 10 ft. wide at the top and 151 ft. 4 ins. at the bottom. The reservoir was built in 1888-9 with Mr. J. Herbert Shedd, M. Am. Soc. C. E., as engineer, and Mr. Jas. J. Newman as contractor, both being of Providence, R. I.

A test of the Woolf water purification plant at Brewster's, in the Croton watershed, was begun on Aug. 8, in the presence of the principal city officials. Chemical and bacteriological analyses of the water before and after treatment will be made by Dr. E. W. Martin, Chemist to the Heath Department. At the time of the test water was being drawn from the Bog Brook reservoir at the rate of 50,000,000 and from the Sodom reservoir at the rate of 20,000,000 gallons per day. It is stated that the Bog Brook reservoir has not been drawn upon before and that it contains much vegetable matter. A 2% solution of salt and water, treated electrically, was discharged into the east branch of the Croton River through a perforated pipe at the rate of 1,000 gallons per hour. Further information regarding this process was given in our issues of July 27 and Aug. 3, 1893.

THE ECONOMICS OF CEMENT MORTARS.

By L. C. Sabin.

In the design of masonry structures the propriety of using Portland cement is sometimes clearly indicated. For instance, in the construction of concrete blocks that must be handled within a limited time, the use of Portland cement is imperative, and if concrete is to be subjected to "wash" at an early stage a quick setting Portland cement will properly be selected. It is frequently the case, however, that the choice between natural and Portland cement depends simply on the relative economy of the two, and it is upon this case alone that the present discussion bears.

Where the designer is not very familiar with the value of natural cement, the rule "When in doubt play trumps" seems to be transformed to "When in doubt use Portland," and it may be added that the transformed rule is no better than the original. In the course of tests of cement for the 800-ft. lock being constructed at St. Mary's Falls Canal, Mich., a series of experiments has been made which forms the basis of the following comparisons of the strength and cost of mortars.

Tables 1 and 2 give the strength attained by various mortars at the age of six months, and Table 3 gives the cost per cubic yard of both Portland and natural cement mortars made with varying proportions of sand. It will be noted that the proportions given in these tables are by weight. Since until recent years mortars for testing in this country were made to contain a given number of parts of sand to one part cement by measure, and since even now the proportions used in actual work are determined largely in the same way, it may be proper to say a word in defense of the method here used.

The report of the Committee of the American Society of Civil Engineers on a Uniform System for Tests of Cement, says that "the quantities used in the mixture should be determined by weight." In view of the general practice prevailing in this country previous to that report, it might not have been a waste of words to have been a little more specific in this phrase. This practice was to obtain weights corresponding to one part cement by volume and one, two, three, etc., parts of sand by volame, and use these weights for all tests with that sample of cement. To say that by this method the quantities used in the mixture were "determined by weight" would seem to be correct. But no doubt is left as to the real meaning of the report, since it gives the quantities required for making five briquettes of one to three mixture as "1¼ lbs. of sand and 6⅜ oz. of cement."

Let us see if the use of volumetric proportions in tests similar to those recorded in Table 2 would give results which would show the comparative values of the cements. Barrel 18's of "G n" brand weighed 47 lbs. 10 oz. per cu. ft., when let fall lightly 2 ft. into a box of ¼ cu. ft. capacity, while barrel 10's of "B n" brand weighed 55 lbs. 7 oz. when treated in the same way. The sand weighed about 100 lbs. per cu. ft. To obtain a 1 to 1 mortar by volume for barrel 18's 35.7 oz. of sand would have been mixed with 17 oz. of cement, while but 30.7 oz. of sand would have been required to be equal in volume to 17 oz. cement from barrel 10's. Now, while cement is often purchased by the barrel or sack, it is really bought by weight, since all carefully drawn specifications fix an average gross or net weight for the barrels or sacks. Would, then, results derived from mortars of proportions given above indicate the relative values of the cements? The heavier cement would obviously have the advantage.

To apply the gravimetric method of proportioning to actual construction would, perhaps, be inconvenient, but that it would be more nearly accurate there is little doubt. As to the change of volume of sand by the addition of small quantities of water, there is a very full abstract of an article on the subject in Engineering News of March 26, 1892. The author of that article finds that the addition of "2% of water reduces the weight of the sand 20%, as compared with the same measure of dry sand." As to the cement, both the weight and volume of the packed cement may be readily known when only full barrels are used, but if a fraction of a barrel is used in the mixture, and it is to be measured, such is not the case—an uncertainty is at once introduced. Now, 3.75 cu. ft. of packed natural cement may swell to 5 cu. ft. when measured loose. This is known to be true by actual experiment on a barrel of natural cement weighing 300 lbs. gross; 3.75 is to 5 as 3 is to 4. If the inspector is ignorant of such changes in volume or is not careful to see that the proper weight of cement is used in the mixture, how easily may a nominal 1 to 3 mortar be changed to an actual 1 to 4 mortar, reducing the indicated strength, according to Table 2, from 280 lbs. per sq. in. to 193 lbs. per sq. in. The hope—perhaps I should say dream—of those especially interested in cements is to place the use as well as the testing of cements on a basis at least approximating that on which rest the use and testing of metals. It would seem that the substitution of weight for measure wherever possible would be a step in the right direction.

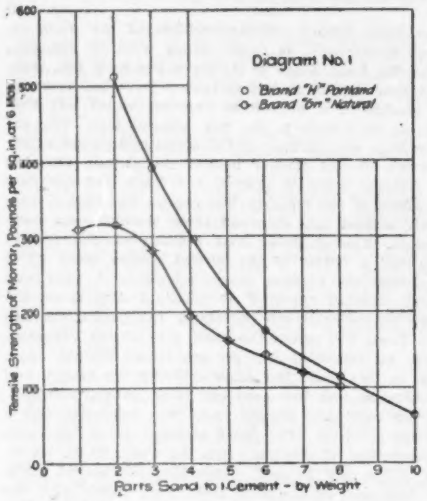
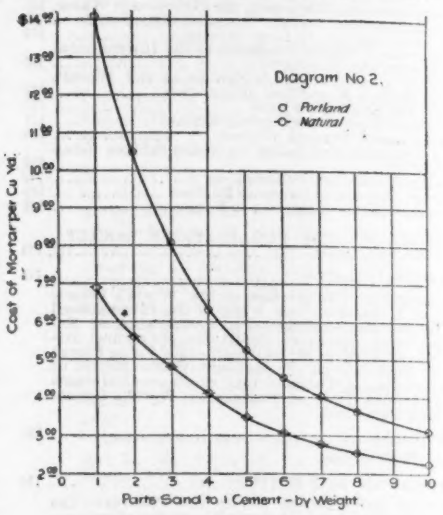
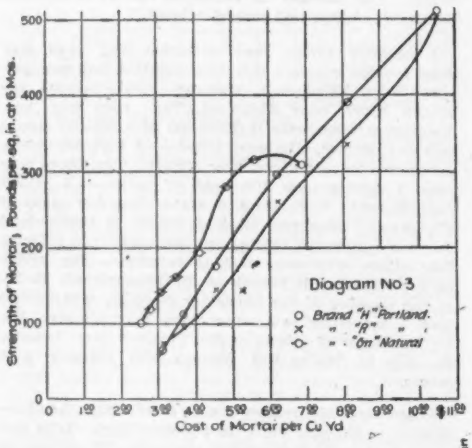


Diagram No. 1
Brand "H" Portland
Brand "On" Natural
Tensile Strength of Mortar, Pounds per sq. in. at 6 Mos.
Parts Sand to 1 Cement - by Weight





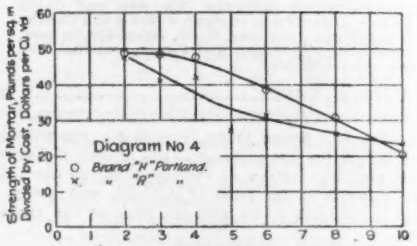


Diagram No 4
Brand "H" Portland.
" "R" "
Strength of Mortar, Pounds per sq. in Divided by Cost, Dollars per Cu Yd
Parts Sand to 1 Cement - by Weight

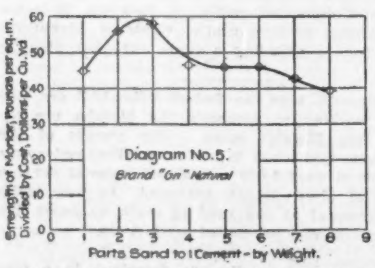


Diagram No. 5.
Brand "On" Natural
Strength of Mortar, Pounds per sq. in. Divided by Cost, Dollars per Cu. Yd
Parts Sand to 1 Cement - by Weight.

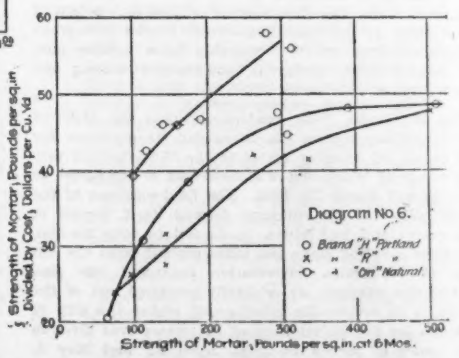


Diagram No 6.
Brand "H" Portland
" "R" "
" "On" Natural
Strength of Mortar, Pounds per sq. in. Divided by Cost, Dollars per Cu. Yd
Strength of Mortar, Pounds per sq. in. at 6 Mos.

DIAGRAMS OF COSTS AND STRENGTHS OF CEMENT MORTARS OF VARYING COMPOSITIONS.

The tables of strength were obtained by breaking briquettes, of the form recommended by the American Society of Civil Engineers committee of 1885, with a Riehle clip whose gripping points were worn so as to fit the briquette perfectly and give a section at the gripping points of 1 5-16 ins. × 1 in. Sufficient water was used to make the mortar rather stiffer than that which is ordinarily used in actual practice. In all cases (except one noted in remarks) the mortars were brought to the same consistency as nearly as this could be judged. The mortar was thoroughly gaged with a hoe in an iron mixing box, pressed into the molds with the fingers and smoothed off with a trowel. On finishing, a little moisture appeared at the top. All briquettes were made by the same molder and left 24 hours in moist air before immersion, except in the case of mortars containing a large percentage of sand, which required 48 hours, and in two cases 66 hours, in air before immersion. The sand used is a fairly good natural sand containing about 50% of particles which will not pass holes .015 in. square, and no particles larger than .08 in. square. Quite a large percentage of the grains are quartz, but they are not sharp, though the sand seems fairly "gritty" when rubbed moist in the hand.

In diagram No. 1 part of the results in Tables 1 and 2 are plotted. It is seen that a one to two mortar in the case of "G n" brand of natural cement is stronger than a one to one mortar. This is not infrequently the case with samples of natural cement. In actual practice so rich a natural cement mortar as one to one by weight is very seldom used. In determining the cost of mortars, Table 3, Portland cement is assumed to cost $3 per barrel of 380 lbs. net, and natural cement $1.30 per barrel of 280 lbs. net (the prices paid by the government for cement used in the construction of the 800-ft. lock). The sand is assumed to cost $1 per cu. yd., though at this point the sand could be furnished considerably cheaper than this, as it is pumped from the bed of the river, about five miles above the site of the lock. The sand weighs about 100 lbs. per cu. ft., and when filled loosely into a measure about three-eighths of the bulk is voids. If 4.25 cu. ft. of loose Portland cement is

mixed with 3.8 cu. ft. of dry sand having three-eighths of the bulk voids it might be thought that this would make $3.8 \times \frac{5}{8} + 4.25 = 6.63$ cu. ft. of mortar, but such is not the case—it will make something less than this amount. But it was found by experiment with both Portland and natural cements that if the Portland was considered as packed to weigh about 104 lbs. per cu. ft. and the natural to weigh about 75 lbs. per cu. ft. this shrinkage did not take place. The experiments on this point were not exhaustive, but it is assured that results are very nearly correct when figured on this basis.

To illustrate the method of determining cost consider a one to one Portland mortar: 1 bbl. cement,

Table I.—Showing Strength of Portland Cement Mortars at Six Months' Age.

(The number of briquettes averaged was 5 in each case except for samples 13, 19 and 22, where it was 4 each, and sample 25, 3 only.

Refer.	Cement. Brand.	Sample.	Snd, parts to 1 cem. by w.	Water, % of dry ingredients.	Tensile strength. Mean, lbs.	Highest, lbs.	Lowest, lbs.
1	H.	21s	2	10.3	512	541	477
2	R.	30s	2	10.3	504	534	486
3	G.	1	2	10.3	438	478	414
4	A.	20s	2	10.3	432	454	396
5	I.	8s	2	10.3	420	450	370
6	H.	21s	3	11.5	390	418	368
7	R.	30s	3	11.5	335	368	304
8	H.	21s	4.09	10.7	295	304	286
9	R.	30s	4.09	10.7	261	276	245
10	A.	20s	4.09	10.7	228	252	203
11	R.	30s	5	11.8	144	154	126
12	A.	20s	5	11.8	159	182	140
13	H.	21s	6	12.2	175	186	162
14	R.	30s	6	12.2	144	157	134
15	I.	8s	6	12.2	134	148	123
16	H.	21s	8	12.1	113	120	109
17	R.	30s	8	12.1	90	110	85
18	G.	1	8	12.1	96	104	90
19	A.	20s	8	12.1	108	114	102
20	I.	8s	8	12.1	89	100	82
21	H.	21s	10	12.1	64	72	60
22	R.	30s	10	12.1	74	84	66
23	G.	1	10	12.1	65	75	62
24	A.	20s	10	12 1	58	67	53
25	I.	8s	10	12 1	60	67	51

Samples 1, 2, 3, 4 and 5 passed 93%, 91%, 91%, 88% and 93%, respectively, through sieve with .0065 sq. in. holes.
Sample 11 and following were immersed 48 hours after being molded.

380 lbs. = 3.65 cu. ft. packed, and 380 lbs. of sand = 3.80 cu. ft. $3.80 - (\frac{5}{8} \times 3.80) \times 3.65 = 6.03$ cu. ft. mortar; (as the result of many experiments made on the work here this quantity was found not to vary much from 6 cu. ft.) Now, 1 bbl. cement costs $3 and 3.8 cu. ft. sand costs 14 cts. Therefore the cost of 6.03 cu. ft. mortar is $3.14, and

$$\frac{3.14}{6.03} \times 27 = \$14.07,$$ cost of cu. yd. of mortar.

Likewise for the natural one to two mortar: 1 bbl. cement, 280 lbs., = about 3.75 cu. ft. packed, and 560 lbs. of sand = 5.6 cu. ft. $5.6 - (\frac{5}{8} \times 5.6) + 3.75 = 7.25$ cu. ft. mortar. One barrel of cement costs $1.30 and 5.6 cu. ft. sand costs .21 ct. Therefore the cost of 7.25 cu. ft. mortar is $1.51,

$$\frac{1.51}{7.25} \times 27 = \$5.62,$$ cost of 1 cu. yd.

Diagram No. 2 is constructed from the information given in Table 3. In diagram No. 3 the or-

Table 2.—Showing Strength of Natural Cement Mortars at Six Months Age.

(The number of briquettes tested was five in each case, except for sample 17, when it was four.)

Cement. Brand.	Sample.	Sand-parts to one cement by weight.	Water per cent. of dry ingredients.	Tensile strength. Mean. Lbs.	Highest. Lbs.	Lowest. Lbs.
1. Gn.	18s	1	17.6	308	335	258
2. En.	15s	1	16 2	290	307	277
3. Fn.	19s	1	16.2	350	409	324
4. Bn.	10s	1	18.7	237	252	226
5. An.	13s	1	17.6	381	393	360
6. Gn.	18s	2	13.3	314	332	291
7. En.	15s	2	12.1	268	278	250
8. Dn.	9s	2	12.1	339	354	320
9. Cn.	14s	2	13.3	301	313	282
10. Gn.	18s	3	12.5	280	301	265
11 Gn.	18s	4	12.0	193	202	180
12. Fn.	19s	4	12.0	124	128	121
13. Dn.	9s	4	12.0	201	211	194
14. An	13s	4	12.0	181	191	174
15. Gn.	18s	5	11.1	161	170	148
16 Gn.	18s	6	11.4	142	160	112
17. En.	15s	6	11.4	74	84	61
18. Dn.	9s	6	11.4	131	157	110
19. Gn.	18s	7	11.5	119	134	109
20. Gn	18s	8	12.1	101	110	94

Samples 1, 2 and 3 passed 89 per cent. through sieve with .0065 sq. in. holes; sample 4, 75 per cent. sample 5, 86 per cent., samples 8, 79 per cent. and sample 9 86 per cent. Sample 18 immersed 45 hours after molding and samples 19 and 20, 66 hours.

dinates represent the strength per sq. in. (Tables 1 and 2) and the abscissas the cost of the mortar per cu. yd. (Table 3). An inspection of this diagram shows that if a mortar is required having a tensile strength of about 300 lbs. per sq. in. the cost of the mortar per cu. yd. would be something over $5 if natural cement were used and something over $6 if the best Portland were employed. Similarly a strength of 160 lbs. per sq. in. can be obtained at a cost of about $3.50 per cu. yd. of mortar for natural, against $4.30 per cu. yd. for Portland. If, however, a strength much above 300 lbs. per sq. in. is required, a natural cement of the quality of this sample cannot be used. It must be remembered that the strengths given are from laboratory tests, and can only be considered proportional to what may be obtained in actual construction. The deduction would seem to be that it is not economical to mix Portland cement with more than four parts sand by weight; for the results may be obtained at a less cost by the use of natural cement. It should be emphasized that this deduction must not be taken as general. It is simply true for the qualities of cement which are examined in this series of experiments and for the prices assumed. The cements used in this series include some of the best brands of American and foreign Portland, and of American natural cements. In some locations an excellent Portland cement can be obtained at a fairly reasonable cost when the natural cement procurable is of indifferent quality or has a prohibitory price.

Table 3.—Showing ingredients required for 1 cu. yd. of mortar, and cost in detail.

Sand, parts by weight to one cement.	Portland.* Cement Bbls.	Cement Cost.	Sand Cu. yd.	Sand Cost.	Total cost mortar, per cu. yd.	Natural. Cement Bbls.	Cement Cost.	Sand Cu. yd.	Sand Cost.	Total cost mortar, per cu. yd.
1.	4.48	$13.44	0.63	$0.63	$14.07	4.91	$6.38	.51	$0.51	$6.89
2.	3.21	9.63	0.90	0 90	10.53	3.72	4.84	.77	0.77	5.61
3.	2.37	7.11	1.	1.00	8 11	3.00	3.90	.93	0.93	4.83
4.	1.78	5.33	1.	1.00	6.33	2.41	3.13	1.	1.00	4.13
4.09	1 74	5.21	1.	1.00	6.21	....	...	....	....	...
5.	1.42	4.26	1.	1.00	5.26	1.92	2.50	1.	1.00	3.50
6.	1.18	3.55	1.	1.00	4.55	1.61	2.09	1.	1.00	3.09
7.	1.02	3.05	1.	1.00	4.05	1.38	1.79	1.	1.00	2.79
8.	.89	2 66	1.	1.00	3.66	1.21	1.57	1.	1.00	2.57
10.	.71	2.13	1.	1.00	3.13	.97	1.26	1.	1.00	2.26

* Cost of Portland cement per bbl. of 380 lbs net, $3.00.
Cost of natural cement per bbl. of 280 lbs. net, $1.50.
Cost of sand per cu. yd., 100 lbs., $1.00.

Table 4.—Showing Strength and Cost of Portland and Natural Cement Mortars Compared.

Sand-parts by weight to one cement.	Mean tensile strength. Lbs. per sq. in. at six mos. d.	Cost of mortar per cu. yd. e.	Col. "c." Col. "d."	Col. "d." Col. "e."
	Portland Cement.			Lbs.
2.	512	10.53	$.0206	48.6
3.	390	8.11	.0208	48.1
4.09	295	6.21	.0211	47.5
6.	175	4.55	.0260	38.5
8.	113	3.66	.0324	30.9
10	64	3.13	.0489	20.4
2.	504	10.53	.0209	47.9
3	335	8.11	.0242	41.3
4.09	261	6.21	.0238	42.0
5.	144	5.26	.0365	27.4
6.	144	4.55	.0316	31.6
8.	95	3.66	.0381	26.2
10.	74	3.13	.0423	23.6
	Natural Cement.			
1.	308	6.89	$.0224	44.7
2.	314	5.61	.0179	56.0
3.	280	4.83	.0172	58.0
4.	195	4.13	.0214	46.7
5.	101	3.50	.0217	46.0
6.	142	3.09	.0218	46.0
7.	119	2.79	.0234	42.6
8.	101	2.57	.0254	39.3

Table 4 shows the relative economy in the use of mortars containing different proportions of sand. In using brand "H," Portland, a mortar composed of six parts sand by weight to one cement gives a strength of 38.5 lbs. per sq. in. for each dollar that the mortar cost per cu. yd. and if but two parts sand are used the corresponding quantity is 48.6 lbs. This is represented graphically in diagram No. 4, and it is seen that, with the prices here assumed and the strengths given in Table 1, the addition of sand to Portland cement beyond two parts by weight causes the strength of the mortar to decrease more rapidly than the cost. Similarly diagram No. 5, constructed from the same table, indicates that for mortars made with "G n" brand of natural cement the maximum strength with reference to the cost is obtained by the use of between two and three parts sand (apparently about 2.6 parts for this sample) to one of cement. Diagram No. 6 presents the results of Table 4 in a different way, the abscissas being the strength of the mortar in pounds per sq. in. This diagram only serves to emphasize the deductions drawn from diagram No. 3.

Finally, the conclusions, subject to the limitations to which attention has been called in the body of the discussion, may be summarized as follows: (1). The gravimetric method of proportioning materials for mortar should always be employed in making tests of cement. It should also be used in actual construction where the general methods of work are accurate enough to justify some sacrifice of convenience. (2). Wherever such a strength is required as can be obtained with natural cement mortar economy dictates its use in preference to Portland. (3). In using Portland cement the addition of sand beyond two parts by weight results in a greater decrease in strength than in cost. (4). In using natural cement the maximum strength with reference to cost is obtained by the use of between two and three parts sand by weight. But the characteristics of different sands and of different brands of cement as to sand carrying capacity vary so widely that this conclusion is peculiarly subject to variation.

SOME QUESTIONS CONCERNING THE FILTRATION OF WATER.*

By W. Kuemmel, C. E., Altona, Germany.

The Imperial Board of Health in Berlin was led by the violent epidemic of cholera in Hamburg to compile, some months ago, the principles derived from the experience of water-works employing sand filtration. The most important of these principles are as follows:

(1) Sand filters do not deliver the water totally free from microbes; they restrain only a certain number of them, including the microbes of the cholera; therefore the filters should never be overworked.

(2) The velocity of filtration ought not to exceed 4 ins. (100 mm.) per hour.

(3) The stratum of the filtering sand should never be less than 12 ins. (30 cm.) thick.

(4) When a filter has been cleaned, or filled up with new sand, it is necessary to waste the first filtered water, with its high number of germs.

(5) The effect of filtration must be daily controlled by bacteriological tests of each filter. If the bacteriologist finds suddenly a greater number of germs, or unusual species of microbes, in the filtered water, such water should not be used at all.

(6) If these principles are carefully followed the danger of the microbes of cholera passing through the filtering sand stratum is exceedingly small, as has recently been proved by the Altona water-works compared with Hamburg.

The author of this publication is believed to be Dr. Robert Koch, at Berlin, the discoverer of the microbes of phthisis and of cholera, who has for many years been making inquiries into the effect of filtration, and these rules are, therefore, the result of a large experience. The writer is sure that the majority of his colleagues who are busy with filtration will, in conformity with their own experience, accept most of them; but some will be in doubt whether all the rules are exactly correct.

The publication of the Board, really a governmental order in Germany, limits the maximum velocity of filtration to 4 ins. per hour, or 8 ft. per day, or 60 U. S. gallons per sq. ft. per day. As far as the writer is instructed about the rate of filtration now used in English water-works, he finds these numbers corresponding with those in use there, as an average in some works, but as a maximum in others. It is not very many years ago that in England the average quantity of filtration was about 50% more than 8 cu. ft. per sq. ft. of the filtering area; and this quantity has been delivered in Germany, too, chiefly by water-works having a water with few earthy ingredients. Why shall we take the 4-in. velocity as a standard for a safe and sure filtration?

Mr. Bertschinger, chemist and bacteriologist of the corporation of Zurich, published a paper in 1889 concerning "The Working of Sand Filters in Zurich." In this paper he approves, after a long series of trials, velocities of from 9 to 44 ft. per day.

Mr. Piefke, engineer of the Stralau station, Berlin water-works, writes in 1887* that his filter delivers the water nearly sterile at a velocity of 30 ins. per day; that the velocity of 4 ft. 9 ins. to 6 ft. 4 ins. per day would be for his works tolerable; but 8 ft.

*Abstract of a paper prepared for the International Engineering Congress of the Columbian Exposition, 1893. Mr. Kuemmel died at Chicago, just before the opening of the Congress.

per day should be the maximum for new works. Notwithstanding, it is stated in another paper, issued by Dr. C. Fraenkel and Mr. Piefke, that on March 12, 1889, the Stralau works filtered with a velocity of 17 ft. 11.5 ins. per day. The bad working of the filters caused the authors named to make a series of trials with pathogenic and non-pathogenic microbes, from which they stated that the pathogenic microbes pass the filter even at a very low velocity of filtration; but, it may be added, under the supposition that the raw, unfiltered water be mixed with the microbes at the rate of 500 to 700 cu. cm., and the filter be ill-treated as it was by the authors of these tests. Messrs. Fraenkel and Piefke conclude from their experiment that filters should not be worked with a velocity exceeding 4 ft. per day.

Mr. Piefke two years later repeated the experiments, without repeating the mistakes of the first series. The result was nearly the same; but he worked again with a water containing a number of pathogenic microbes, such as we absolutely cannot find in a polluted river or pond used for water delivery.

The writer himself has also made a great number of trials to find the best velocity for the filtration of water. To avoid every error or mistake resulting from the difference in the quality of the unfiltered water he built three experimental filters, filled with the same filtering materials, all conditions being exactly the same, only the velocity of filtration being different. As soon as the three filters were in good condition the experiment began, the water running through the filters at a velocity of 4, 8 and 16 ft. per day. The number of the microbes varied with a 4-ft. velocity from 11 to 97; with an 8-ft. velocity from 5 to 79; and with a 16-ft. velocity from 7 to 72 per cu. cm. The difference is not sufficient to declare the one velocity better than the other, and therefore the writer cannot agree that the velocity of 8 ft. is, beyond doubt, the maximum of safe filtration. Notwithstanding, the writer accepts this standard as long as better experiments do not prove it to be false, because he believes the danger of a trespassing pathogenic microbe is much more trifling at the lower than at the higher velocity; and, besides, that the best velocity is not the same for different qualities of water. He is sure that the difference in the mineral, vegetable and animal admixtures is of high importance in this connection, and that we should endeavor to find out the best velocity for each water-works.

A second point that is often disputed is contained in Clause 4. According to the present state of science and experience it is generally accepted that the thin film of dirt on the surface of the sand is really the filtering medium, and that the filters, filled up with new sand or cleaned, do not properly work before a new film of dirt has been gained. Mr. Bertschinger's experiments show that the Zurich filters do not do their full duty until four to seven days after the cleaning. Mr. Piefke's experiments at Berlin show the filter fully restored after four or five days' working. The unfiltered water in Zurich is of a first-rate purity compared with the water of the Spree in Berlin and of the Elbe near Altona. The raw Zurich water contains generally less than 300, in very rare cases, 400, germs; the water of the Spree generally some thousands, very seldom more than 10,000, germs; while the water of the Elbe at the Altona water-works contains exceedingly seldom less than 10,000, generally more than 20,000, and very often more than 40,000, germs per cu. cm. On the other hand, in the Elbe water the amount of mineral substances is very high, the amount of vegetable matter very low, compared with the Spree water. The mineral matter subsides very fast, as soon as the water is brought to rest. The writer, therefore, fills up the cleaned or newly filled filter (at the Altona works) in the usual way from below with filtered water to the top of the sand, and afterward with unfiltered, subsided water from above, and then gives a sufficient time for the mineral impurities to subside on the surface of the sand. Generally six to eight hours, sometimes 10 or 12 hours, after the time the filter is filled with water the filtration begins and is quite satisfactory, the number of microbes being not, or very little, increased, as compared with the water filtered before the cleaning.

Quite a different case is that after the filling up with new sand. If we proceed just in the same way with the inlet water and give the raw water a time of 20 hours of quiet rest, the number of microbes becomes very high. It is certain that the working of the filter, when filled up with new sand, is for a certain time not satisfactory; therefore, we must waste the water during the first three or four days.

A third point to be discussed is contained in Clause (5). It is not sufficient to examine the water as it is delivered to customers: the water running from each filter must be tested bacteriologically every day. We have made arrangements to take the samples from each filter, as near as we could get. At first there were attached to the outlet pipes short lead pipes with bib cocks, and the water was drawn from these cocks, about 2 ft. from the mains. That was a mistake; some days after the first trial the lead pipes were grown full with microbes, and the samples of water taken from the bibs, though full care was taken to have the water from the mains, did not show the latter, because the running water washed away many of the colonies in the lead pipes. Now the arrangement is altered; we take the water directly from the main with a sterilized short pipe, introduced in the main through a properly constructed stop-cock.

We find it a very good thing to examine every day each of the filters, and we are sure that we save ourselves a great many mistakes and much mischief by this very simple and very safe expedient. Without this bacteriological examination we are working like a mechanical engineer who does not indicate his steam engine, thinking that he is able to estimate its quality from the revolution of the flywheel. The thing we must not overlook is that the number of germs found in a cubic centimeter is not very important in itself, but only a way to judge the working of the filter. As soon as we find that the number increases suddenly, we may be sure that something in our filter is out of order.

A point of much greater importance is the determination of the species of the microbes; in each sample of a good filtered water the number of species will not exceed five or seven, and these species will not vary much, though different species predominate at different seasons. As soon as we find that the water contains some well known species of microbes of the liquefying type, we have to examine the colonies in the disks and the filters with the utmost care. If we do so, we may be sure that we will be able to deliver a good, safely usable filtered water, even from a river not at all protected against pollution through human dejections.

*Principien der Reinwasser-Gewinnung mittelst Filtration. (Principles of Obtaining Pure Water by Filtration.)

AN EVAPORATIVE SURFACE CONDENSER.*

By James H. Fitts.

The condenser herein described was built at the Virginia Agricultural and Mechanical College at Blacksburgh, Va., after some observations were made on the rate of evaporation of water at different temperatures, and with a current of air passed over its surface. Its performance has been successful to such a degree that this paper is presented, in the belief that it will be of general interest to the profession, and that it gives a practical solution of the question of condensation of vapor with a small water supply. While it may meet with criticism for its crudities, the author hopes to avail himself of this to make good any deficiencies for a future meeting of the society.

This condenser (Fig. 1) consists of two rectangular end chambers connected by a series of horizontal, rows of tubes, 8 in some and 7 in others; 210 tubes in all. The tubes are of brass, ⅝ in. external diameter and 4 ft. 9½ ins. in length. The internal cooling surface is 176.5 sq. ft.

There are 27 cooling pans, each 4 ft. × 9½ ins. × 1 ft. 9⅝ ins. and 1 7-16 ins. deep. These pans have galvanized iron bottoms, which slide into horizontal grooves, ¼ in. wide and ¼ in. deep, planed into the tube sheets. Wooden strips are fitted into the grooves below the bottoms. The tube sheets form the ends; and angle irons 1⅜ × ⅝ × ⅛ in., bolted to the galvanized bottoms, the joints packed with wooden strips form the sides. The total evaporating surface is 234.8 sq. ft. Water is fed to every third pan through small brass cocks, and 1¼ ins. overflow-pipes feed the rest. (The drawing does not show the method of water supply.)

A wood casing connects one side with a 30-in. Buffalo Forge Co.'s disk wheel. This wheel is belted to a 3 × 4-in. vertical engine. The air pump is 5¾ ins. diameter, with a 6-in. stroke, is vertical and single acting. This pump acts imperfectly, due partly to a defective cylinder casting, and can produce a vacuum of only 24 ins. of mercury when steam is not admitted to the condenser. As the normal barometer reading is 28 ins., this indicates a residual air pressure of 4 ins.

The action of this condenser is clear. The passage of air over the water surfaces removes the vapor as it rises, and thus hastens evaporation. The heat necessary to produce evaporation is obtained from the steam in the tubes, causing the steam to condense. It was designed for the college shop engine, to condense 800 lbs. steam per hour and give a vacuum of 22 ins., with a terminal pressure in the cylinder of 20 lbs. absolute; but it was found practically impossible to get the long exhaust pipe air-tight, on account of its numerous connections. Direct connection was, therefore made with the boiler. A number of runs of several hours' duration had been made with a boiler pressure of 60 to 70 lbs. The cooling water was run into a barrel placed overhead, and drawn from the barrel. The water of condensation was weighed. The following table gives average results:

Boiler pressure, lbs. per sq. in. per gage	65
Temperature, in degrees Fahrenheit—	
Steam	311
Cooling water (initial)	60
Water in pans above diaphragm	140
" " below "	115
Hot well	149
Air	70
Dew point	62
Working strokes of air-pump	90
Revolutions exhaust fan per min.	740
Velocity of air, ft. per min.	2,300
Quantity of air moved, cu. ft. per min.	6,500
Horse power expended in driving fan	½
Barometer in inches	28
Cooling water used, lbs. per hour	1,350
Steam condensed, " " "	900
Vacuum in ins. of mercury	16¾
Vacuum reduced to barometer at 30	18½

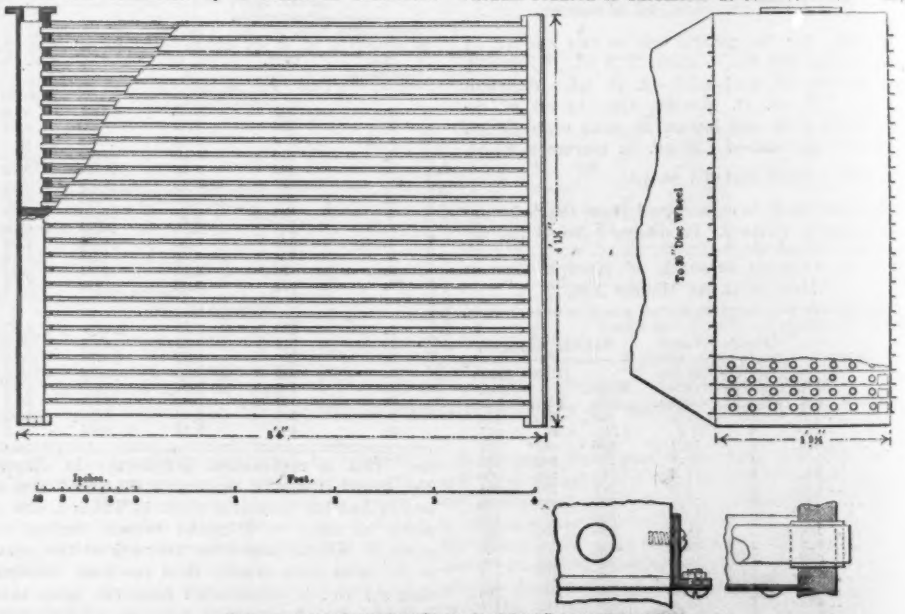


FIG. 1.—AN EVAPORATIVE SURFACE CONDENSER.

rows of tubes, each row of tubes immersed in a pan of water. Through the spaces between the surface of the water in each pan and the bottom of the pan above, air is drawn by means of an exhaust fan. At the top of one of the end chambers is an inlet for steam, and a horizontal diaphragm about midway causes the steam to traverse the upper half of the tubes and back through the lower. An outlet at the bottom leads to the air pump.

The condenser, exclusive of connection to the exhaust fan, occupies a floor space of 5 ft. 4½ ins. × 1 ft. 9⅝ ins., and is 4 ft. 1½ ins. high. There are 27

The overflow pipes for regulating the supply of water were found to be too small, so that at times some pans would be too full, causing waste of water over the edges, and at others the tubes would be uncovered, with reduction in efficiency. This loss of cooling water will account for the amount being so much in excess of the water of condensation. The amount of steam condensed, if there had been no waste of water, would have been about 30 lbs. less than that shown.

Accurate analysis of the transfer of heat could

*A paper presented at the Chicago meeting of the American Society Mechanical Engineers.

not be made on account of this waste. An approximate analysis, however, may be based on information obtained from the curve of evaporation given below.

Heat in 1 lb. steam at 311° = 1,208.3 B. T. U.; heat in 1 lb. water at 140° = 140; heat rejected by 1 lb. steam = 1,208.3 − 140 = 1,059.3. Of each pound of water evaporated in the condenser, probably five-sevenths is at 140° and two-sevenths at 115°. Heat absorbed by five-sevenths lb. water in being warmed

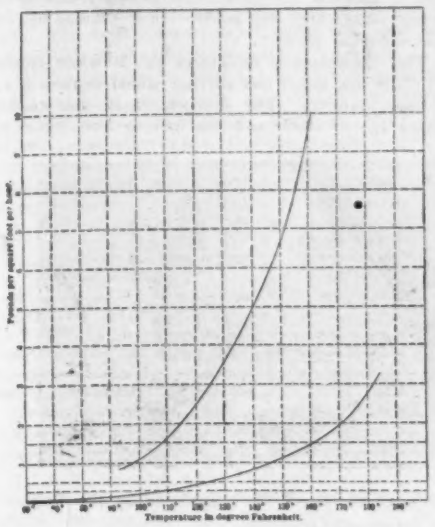


Fig. 2.—Diagram Showing Rate of Evaporation.

from 60° to 140° = 57.1; heat of vaporization of five-sevenths lb.. = 725.5; heat absorbed by two-sevenths lb. water in being warmed from 60° to 115° = 15.7; heat of vaporization of two-sevenths lb. = 299.7; total heat absorbed by 1 lb. water = 57.1 + 725.5 + 15.7 + 299.7 = 1,098.

The cooling water required, then, is practically equal in amount to the steam used by the engine. And since consumption of steam is reduced by the application of a condenser, its use will actually reduce the total quantity of water required.

This condenser is still in crude form, and there are many improvements to be made in it. One of these is obvious: to cool the water of condensation still further by passing it through an attachment similar to the usual type of surface condenser on its way to the air pump, through which the cooling water first circulates. Enough has been done, however, to demonstrate that it is of practical application in any situation, that it is not expensive to construct, is perfectly accessible for cleaning, requires small power to operate, and will give a vacuum of 20 to 22 ins. The floor space required is moderate.

A curve showing the rate of evaporation per square foot of surface is given (Fig. 2), and also one showing the rate when a current of air of about 2,300 ft. per minute velocity is passed over its surface The barometer reading averaged 27.9 ins. during both sets of observations; the dew point for those in still air was 57°, and for those under a current of air 68°.

SEDIMENT CARRIED BY LARGE RIVERS.

Since May, 1891, the U. S. Geological Survey has been measuring the amount of sediment transported by the Potomac River, at Chain Bridge, Washington, D. C. The results of this measurement are now published in "Science," by Mr. C. C. Babb, U. S. Geological Survey.

Daily heights of the Potomac River, at Great Falls, 16 miles above Washington, have been kept since 1878, together with a daily record showing condition of water. This latter record was obtained as follows: A horizontal metallic tube, 36 ins. long and with glass ends, was filled with water and the distance at which a ball immersed therein can be seen from one end is noted. The observations vary from 1 in., in very muddy water, to 36 ins. in very clear water. The water is at the same time analyzed quantitatively and the weight ratio of the sediment to the total weight of sample is ascertained. From 55 samples examined with "condition of water" ranging from 1 in. to 36 ins., the quantities of sediment were plotted on cross-section paper and through the points found a smooth curve was drawn. From this a table was constructed giving for each inch of "condition of water" the corresponding ratio of sediment. In order to obtain the total amount of sediment transported by the river for any length of time the discharge of the river for that period must be multiplied by the average ratio of the sediment to the water for that period.

For one and a half year's simultaneous gage readings of the height of the river were made at Great Falls and Chain Bridge, between which points no tributary enters the river. From the data obtained the daily amounts of sediment from 1886 to 1891 inclusive have been computed from over 2,000 observations. While the results are not classed as scientifically accurate, they are deemed to be sufficiently close for all practical purposes.

The following facts are brought out: The average annual discharge of the Potomac River from a drainage area of 11,043 square miles is 20,160 sec. ft., varying from 2,000 sec. ft. in time of low water up to 470,000 sec. ft. during the great flood of 1889. The total annual amount of sediment transported is 5,557,250 tons, or 353 lbs. per second, and distributed through the six years from 1886 to 1891, as follows: 1886, 4,283,000 tons; 1887, 2,372,800 tons; 1888, 4,996,800 tons; 1889, 10,142,600 tons; 1890, 5,994,000 tons; and 1891, 5,544,300 tons. The average daily amount varied from 1 lb. to 21,900 lbs. per second. It is found from these figures that the average annual amount of sediment is to the weight of the annual discharge of water as 1 to 3,575. Assuming that 1 cu. ft. of sediment weighs 100 lbs., this average amount of sediment would cover one square mile 3.98 ft. in depth, and if spread over the drainage area would cover it 0.0043 in. in depth. At this latter rate it would take the river 2,770 years to erode 1 ft. from the drainage area.

These results appear in the following table, together with similar data compiled for several other large rivers. The first column gives the name of the river; second, its drainage area in

Discharge and Sediment of Large Rivers.

River.	Drainage area, square miles.	Mean annual discharge, second feet.	Sediment: Total annual tons.	Sediment: Ratio by weight.	Sediment: Height column 1 square mile base, ft.	Sediment: Depth over drainage area, in.	Authority.
Potomac	11,043	20,160	5,557,250	1:3575	4.0	.0433	
Mississippi	1,214,000	610,000	406,250,000	1:1560	291.4	.00288	Humphreys and Abbot.
Rio Grande	30,000	1,760	3,830,000	1:291	2.8	.00110	U. S. Geological survey.
Uruguay	150,000	150,000	14,782,500	1:10,000	10.6	.00 85	J. J. Revy.
Rhone	34,800	65,850	36,000,000	1:1775	31.1	.01071	J. Barois.
Po	27,100	62,200	67,000,000	1:900	59.0	.01139	"
Danube	320,300	315,200	108,000,000	1:2880	93.2	.00354	"
Nile	1,100,000	113,000	54,000,000	1:2050	38.8	.00042	"
Irrawaddy	125,000	475,000	291,420,000	1:1610	209.0	.02305	R. Gordon.

square miles; third, the average annual discharge of the river in cubic feet per second. The fourth column gives the total amount of sediment, in tons, annually transported by the river; fifth, the ratio of the weight of this sediment to the weight of the water annually discharged; the sixth, the height of a column in feet having a base of one square mile that the sediment would cover; the seventh, the depth in inches that the drainage area would be covered if this total amount of sediment should be spread over it; and the last column the authority for the data. The discharge and drainage areas for the Rhone, Po, Danube and Uruguay are taken from a paper by John Murray in the "Scottish Geographical Magazine" for February, 1887. The drainage area of the Nile was measured by planimeter from the best maps obtainable.

ABSTRACTS OF PAPERS PRESENTED AT THE INTERNATIONAL ENGINEERING CONGRESS.

(Continued from page 92.)

American Grain Elevators.

A brief description of the several classes of grain elevators and their construction was given in this paper by Mr. E. Lee Heidenreich. The grain elevators in common use in America may be divided into four main classes, viz.: (1) Storage elevators; (2) railway transfer elevators; (3) terminal elevators for rapid handling and storage; (4) cleaning elevators. In addition to these four classes, may be mentioned elevators for unloading vessels and transferring the grain to cars, and small railway station elevators taking grain from farmers' wagons and transferring it to the cars. The construction of the first two classes is generally simple, but that of terminal and cleaning elevators is more difficult owing to the greater amount of machinery required. In closing his paper the author says:

The principal requirements of a grain elevator, namely, strength, tightness, light and effective and accessible machinery, are such as to invite the attention of engineers; and before closing the writer wishes to say that the handling and storing of grain, both in the interior and at the lake and ocean terminals, presents a wide field for future discovery and improvements. Some of the immediate wants are: Larger capacity cleaning machinery, adequate drying apparatus, automatic weighing machinery, fireproof bin construction and pneumatic unloading of cars or vessels with a view of greater capacity per hour than can be obtained at present. And last, but not least, a general use of electricity for driving isolated parts of machinery, or, perhaps, for transmitting power to every piece of machinery in the entire elevator. The main principles which must be kept in view while making these improvements are rapidity and economy of construction, and a reduction of the labor employed in the handling of grain in American grain elevators of the future.

The Development of Quay Cranes in the Port of Hamburg.

In the respect of facilities for handling the cargoes of vessels entering the port of Hamburg, Germany, it is probable that that city is unrivaled by any of the other large seaports of the world. A very complete description of the quay crane system in use was given in a paper presented by Mr. C. Nehls, Hydraulic Director at Hamburg.

The quays of the port extend over a distance of 6⅛ miles, and along them are distributed more or less uniformly 421 cranes, divided as follows:

Stationary Cranes.

Kind.	Capacity, pounds.
1 steam crane	330,000
1 " "	110,000
1 " "	27,500
1 hydraulic crane	11,000
17 " cranes, each	4,400
4 " " "	3,300
4 " lifts	2,200
10 gas cranes, each	880
1 hand crane	88,000
21 " cranes, each	5,500
1 " crane	3,300
4 " cranes, each	2,200

Traveling Cranes.

		Capacity, pounds.
1	steam crane	16,500
3	" cranes, each	11,000
1	" crane	6,600
125	" cranes, each	5,500
123	" " "	3,300
2	electric " "	5,500
6	hand " "	5,500
94	" " "	2,200

These cranes have a collective lifting power of 2,200,000 lbs., or 66 lbs. per lin. ft. of quay. The traveling cranes are used mostly for handling the cargoes into and out of the vessels, since they can be easily shifted to accommodate the different positions of the hatches in the different vessels, while the fixed cranes are used to handle unusually heavy loads or where no change of position is required. The motive power of most of the traveling cranes is steam or hand power, and their construction possesses nothing of especial novelty. In regard to the electric cranes it is stated that they have proved successful, especially in periods of severe frost, when they showed the advantage of their dry working over steam cranes. The current is taken from accumulators charged by dynamos, and the mechanism is so arranged that the descending load produces a return current which is used to relieve the dynamos. There is stated to be a great saving in building and working expenses with these cranes as compared with the steam cranes of the same efficiency.

The largest fixed crane is of 330,000 lbs. capacity, and swings on a pivot which is fastened to the foundation with heavy stays. It moves on 32 steel rollers 19¾ ins. in diameter and 7 ins. wide, traveling on a track of cast steel; the projection of the crane jib from the center of pivot to the chain being 58¾ ft., and 33 ft. outside of the quay wall. The height of the pulley over the top of quay is 101 ft. This considerable height was arranged in

order to be able to lift or to set up masts of sailing vessels when required. A ballast tank is arranged, filled with sand, with a total weight of 25 tons; this serves as a balancing weight when lifting.

The boiler and engine are arranged in a separate iron casing of the crane. The boiler has a heating surface of 376 sq. ft. and a working pressure of 75 lbs. The engine is of the double-cylinder type, each cylinder having a diameter of 12 ins. and a stroke of 22 ins., and is fitted with a double crank-shaft and with Meyer's expansion valve gear. The revolutions are 60 per minute. A flat link chain of steel is used as a lifting chain. The total dead weight of the crane amounts to 230 tons, exclusive of ballast. Weights of 150 tons can be lifted 20 ft. in a quarter of an hour, and one revolution of the crane can be completed in five minutes. The crane foundation is based upon 180 piles. The cost of the crane, exclusive of foundation, amounted to about $42,000.

Common Roads, Railways and River Communications in Portugal.

A paper on these subjects was presented by Mr. Frederico Augusto Pimental.

Common Roads.—There are three classes of highways in Portugal, as follows: First-class, or royal roads, which connect Lisbon with the chief towns of the; second-class, or district roads, which connect the principal towns with each other; and third-class, or municipal roads, which join the townships or cancelhos with the preceding roads. The cost of constructing and maintaining the first and second-class roads is met by the state; and of the third-class by the municipalities in which they are located, except that the state pays one-third the cost of construction. These figures refer to continental Portugal. The normal widths of the three classes of roads, driveways, footways and totals, the maximum grade and the maximum radius for junction curves is as follows, the figures having been converted from meters to feet:

Class.	Width of Driveway.	Footway.	Total way.	Maximum grade %.	Maximum radius junc. curves.
First	14.43	7.22	21.65	5	98.4
Second	13.12	6.56	19.68	5	98.4
Third	11.48	4.92	16.40	7	32.8

The dimensions of first and second-class roads may be enlarged where the traffic demands it.

Railways.—The total railway mileage of Portugal on Dec. 31, 1891, was 1,415 miles, of which 1,294 miles were broad and 121 miles narrow gage, and of which about 500 miles were managed by the state and the balance by companies.

Navigable Ways.—The total length of the navigable ways of Portugal is given as 614 miles, including about 25 miles of canals. The navigable length of the Tagus, the langest river, is 164 miles, and of the Douro, the next longest, 124 miles. The area of continental Portugal is about 34,000 square miles, and its population 4,774,700.

A Brief Account of the Building of Leixoes Harbor.

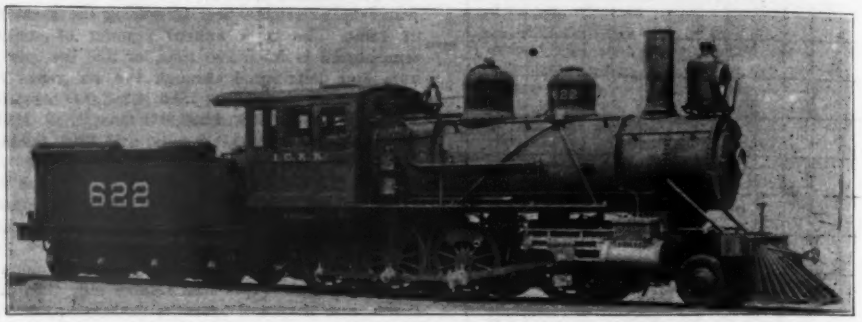
Mr. A. J. N. Soares, Inspecting Engineer in Charge, contributed a paper on this subject. Leixoes Harbor is situated about three miles north of the River Douro (west coast of Portugal) and is formed by two breakwaters, the north one being 5,179 and the south 3,756 ft. in length, so placed in plan as to give a harbor area at low water of 235 acres. In constructing the breakwaters there was used in deep water a foundation of loose rubble stone, assorted in three sizes, the smallest size weighing not over 4,400 lbs., the middle size ranging from this to 96,000 lbs. and the largest size exceeding 17,600 lbs. The seaward slope is protected by artificial blocks, each of about 26 cu. yds. bulk, or 99,000 lbs. weight, made of rubble bedded in mortar and of concrete. The superstructure has hewn stone faces with rubble backing, all laid in mortar and, where most exposed to the sea, joined in artificial blocks, containing about 26 cu. yds.

The width of the substructure at extreme low water is 128.87 ft., while the superstructure at this point is 18.2 ft. The superstructure has a batter on its outer face of 1 to 10 and has a height of 33 ft. to the base, or 37.74 ft. to the top of the parapet, which gives a height of 25 ft. above the highest tide.

In constructing the heads of the breakwaters, the upright wall system was employed, and concrete bags were used to give an even surface to the rock bottom. The height of the submerged part of the heads from their base to extreme low water is 48.9 ft. for the north and 33.36 ft. for the south head, the latter being founded on a large rock about 16.85 ft. high.

ROGERS LOCOMOTIVE CO. EXHIBIT AT THE WORLD'S COLUMBIAN EXPOSITION.

The exhibit of American locomotives at the World's Columbian Exposition is, as we have already shown, a very interesting and comprehensive one, and we have published views and descriptions of the exhibits of the Baldwin and Brooks locomotive works. The Rogers Locomotive Co., Paterson, N. J., exhibits three locomotives, a duplicate of one of which we illustrate herewith, and the particulars of all of which are given in the accompanying table. The engines are a consolidation freight engine for the Illinois Central R. R., a 10-wheel passenger engine for the Charleston & Savannah Ry., and an eight-wheel passenger engine for the Chicago, Burlington & Quincy R. R. They are all standard types of engines, and represent everyday practice in design and construction.



CONSOLIDATION FREIGHT LOCOMOTIVE; ILLINOIS CENTRAL R. R. Exhibited by the Rogers Locomotive Co. at the World's Columbian Exposition.

The Illinois Central R. R. consolidation engine, which we illustrate, has driving wheel centers 4 ft. 1½ ins. diameter, and driving and truck and tender axles of hammered iron, with cast iron driving axle boxes. The engine truck wheels are the Rogers cast iron spoke wheels with steel tires, and the tender truck wheels are of cast iron with double plate and chilled tread. The firebox is between the frames and over the third and fourth axles. The ashpan is of the hopper pattern. The boiler is of the Belpaire type, with butt-jointed horizontal seams and double riveted lap circumferential seams. The boiler feed is supplied by two No. 9 Monitor injectors. The tender frame is of white oaks, and the tender truck frames are of the diamond pattern.

The Charleston & Savannah Ry. 10-wheel engine (4 ft. 9 ins. gage) has driving wheel centers 5 ft. 6 ins. diameter. The driving, truck and tender axles are of steel, and the driving axle boxes of malleable iron. The engine truck wheels are the Allen No. 7 cast iron spoke center with steel tires and retaining rings. The tender trucks have the Allen No. 9 cast iron double plate centers and retaining rings. The firebox is on top of the frames, and the ashpan is in halves with sleeve around the axle. The boiler is of the extended wagon-top type, with radial stays, and having butt-jointed horizontal seams and double riveted lap circumferential seams. The boiler feed is supplied by two No. 9 Monitor injectors. The tender frame is of 9-in. channel iron, and the tender trucks are the Rogers passenger standard.

The Chicago, Burlington & Quincy R. R. eight-wheel engine has driving wheel centers 5 ft. 2 ins. diameter. The driving, truck and tender axles

	Consolidated.	Ten-wheel.	Eight-wheel.
Running Gear—			
Driving wheels, diam.	4 ft. 8½ ins.	6 ft. 0⅛ in.	5 ft. 9 ins.
Truck " "	2 " 9 "	3 " 0 "	3 " 1 in.
Tender " "	3 " 0 "	3 " 0 "	3 " 1 "
Journals, driving axles	8 × 10 ins	8 × 10 ins.	8 × 9¼ ins.
" truck axles	5 × 10 "	5¼ × 12 "	5½ × 9 "
" tender axles	4¼ × 8 "	4¼ × 8 "	4¼ × 8 "
Wheel Base Driving	16 ft. 9 ins.	13 ft. 6 "	8 ft. 6 "
Total engine	24 " 5 "	24 " 8 "	22 " 11¼ "
" tender	15 " 0 "	15 " 9 "	15 " 8 "
" engine and tender	47 " 9½ "	52 " 2 "	48 " 3 "
Weight in working order—On drivers	118,600 lbs.	98,500 lbs.	65,500 lbs.
On truck wheels	18,700 "	34 500 "	36,500 "
Engine, total	137,300 "	133,000 "	102,000 "
Tender, "	78,000 "	80,000 "	72,000 "
Engine and tender, loaded	215,300 "	213,000 "	174,000 "
Cylinders	21 × 24 ins.	19 × 24 ins.	18 × 24 ins.
Distance center to center	7 ft. 2 ins.	7 ft. 3 ins.	6 ft. 4 ins.
Piston rod, diam.	3½ ins.	3¼ in.	3¼ ins.
Piston rod and valve stem packing	U. S. met.	U. S. met.	Jerome met.
Valve Gear			
Ports, steam	1¾ × 18 in.	1⅝ × 19 ins.	1⅝ × 17¼ ins.
" exhaust	2⅛ × 18 "	3¼ × 19 "	3⅜ × 17¼ "
Slide valves	Margash	All. Rich.	Rob'ts'n bal.
" " lap, outside	¾ in.	1 in.	1⅛ ins.
" " " inside	⅛ "	.....	1/32 in. (clearance)
" " lead in full gear	1/32 "	1/32 in.	1/32 in.
" " greatest travel	5½ ins.	5¼ "	6 ins.
Boiler—Type	Belpaire	Ext. wag.top, rod stay	Belpaire
Diam. of barrel, outside	5 ft. 2 in.	4 ft. 10 ins.	4 ft. 8 ins.
Thickness of barrel plates	11/32 and 5/16 in.	⅛ and 7/32 in.	7/32, ⅛ and 7/32 in.
Working steam pressure	165 lbs.	170 lbs.	165 lbs.
Firebox—			
Length inside	10 ft. 1⅝ in.	8 ft. 11⅛ ins.	7 ft. 0 ins.
Width "	2 " 9⅛ "	3 " 6 "	3 " 6 "
Thickness of side plates	11/32 in.	5/16 in.	5/16 in.
" back plate	11/32 "	5/16 "	5/16 "
" crown sheet	½ "	5/16 "	5/16 "
" tube sheet	11/32 "	½ "	½ "
Grate area	28.19 sq. ft.	31.38 sq. ft.	24.5 sq. ft.
Water space, width, front	4 ins.	4 ins.	3 ins.
" " " back and sides	3¼ "	3½ "	3 "
Tubes—Material, iron; number	236	212	217
Diam. outside	2 ins.	2 ins.	2 ins.
Length over tube plates	11 ft. 10⅛ ins.	14 ft. 4 in.	11 ft. 6¼ ins.
Heating Surface—			
Tubes	1 454.5 sq. ft.	1,815 sq. ft.	1,308 sq. ft.
Firebox	168.0 " "	153 " "	110 " "
Total	1,622.5 " "	1,968 " "	1,418 " "
Miscellaneous—			
Exhaust nozzle	Single; high	Single; high	Single; high
Smokestack, smallest diam.	16 ins.	14¼ ins.	13
" height from rail to top	15 ft. 1⅛ ins.	15 ft.	15 ft. 6 ins.
Capacity of tank	3,850 gal.	3,500 gal.	3,480 gal.
Capacity of coal space	15,680 lbs.	15,680 lbs.	15,680 lbs.

are of Cambria steel (Coffin process, Eng. News, Feb. 16,), and the driving axle boxes are of cast iron. The tender axles have collarless journals. The engine and tender trucks have Brunswick steel-tired wheels. The firebox is on top of the frames and has a plain ashpan. The boiler is of the Belpaire type, with butt-jointed horizontal seams and double riveted lap circumferential seams. The boiler feed is supplied by two Pennsylvania R. R. standard Monitor injectors, a No. 9 on the right-hand side, and a No. 8 on the left-hand side. The tender frame is of white oak, and the trucks are of the Rogers passenger standard.

All the engines are intended to burn bituminous coal, and have grates with cast iron rocking finger bars with drop plate in front. The boiler tubes are of iron. The tenders are all of the standard American pattern on two four-wheel trucks. The consolidation engine has flat connecting and side rods, while the other engines have rods of I-section.

PERSONALS.

Mr. R. D. Wade has been appointed Superintendent of Motive Power, and Mr. C. M. Bolton, Chief Engineer, of the Georgia Pacific Ry.

Mr. William S. Mellen, General Manager of the Northern Pacific R. R., died in Victoria, B. C., on July 27 of neuralgia of the heart.

Mr. Paul S. King, who was Chief Engineer of the Lehigh Valley extension to Buffalo during the entire period of construction, has retired from that post.

Mr. J. W. Kendrick, Chief Engineer of the Northern Pacific R. R., has been appointed Acting Manager of leased and operated lines west of St. Paul and Ashland.

Mr. Thos. M. King has been elected President of the Pittsburg & Western R. R. The road is controlled by the Baltimore & Ohio R. R., of which Mr. King is Second Vice-President.

Mr. F. G. Ewald has been appointed Assistant Engineer on the Chicago Drainage District, Rialto Building, Chicago. Mr. Ewald was until recently Resident Engineer of the Atchison, Topeka & Santa Fe R. R., and had held this position, with headquarters in Chicago, for the past six years.

Mr. G. A. Wilson, formerly General Manager of the Interoceanic Ry. of Mexico and well known among railway men in Mexico and South America, has died in Brazil. His father, Jose Wilson, an Englishman, established the first stage coach line in Venezuela, between La Guayra and Caracas, long before the railway was constructed.

Prof. Geo. W. Coakley, who filled the chair of mathematics and astronomy for 30 years in the University of the City of New York and was emeritus professor for the last three years, died in Brooklyn on Aug. 2. He was the author of many valuable papers on mathematical and astronomical subjects, his special subjects of study being comets and meteors.

Mr. E. L. Moffatt, President and General Manager of the Lackawanna Iron & Steel Co., of Scranton, Pa., died in Edinburgh, Scotland, Aug. 3. Mr. Moffatt was born in Easton, Pa., in 1845, studied at Princeton, was an officer during the war of the rebellion, afterward took a three years' course at the Columbia School of Mines, and for two years held a professorship at Lafayette College, which he resigned to become Superintendent of a blast furnace at Port Oram, N. J.

Gen. Wm. P. Innes died at Grand Rapids, Mich., Aug. 2, at the age of 67 years. At an early age he joined the engineering corps of the New York & Erie R. R., where he remained until the completion of the road. In 1853 he went to Michigan and was engaged in important railway work there until 1861, when he organized the regiment of Michigan Engineers and Mechanics, with which he served through the war as its commander. He was then engaged in railway building in Tennessee until failing health compelled him to retire from active work. He was State Railroad Commissioner of that state under Governor Begole, and this was his only public office.

Mr. James P. Hector died at the Hilton ranch, in Maverick County, Texas, July 24, aged 79 years. He graduated from Knoxville (Tenn.) University at the age of 14, and at the age of 19 was Assistant Engineer on the second line of railway built in the United States. From 1846 to 1854 Mr. Hector was Chief Draftsman in the General Land Office at Austin, Tex., and for a number of times he was appointed as Inspector of Public Improvements by the State Legislature. In 1865 he made the survey and selected the site for the dam and canal at Austin. He also, with Major Burns, was the originator of the International & Great Northern Ry., and in person made the preliminary surveys for the road.

Dr. John Rae, the distinguished arctic explorer, died in London July 24. He was born in the Orkney Islands, studied medicine at the University of Edinburgh, and after graduation there he took his degree as Licentiate of the Royal College of Surgeons before he was 23 years old. He was soon appointed surgeon to a ship of the Hudson Bay Co. In 1845 he accepted the command of an expedition in two small boats to the arctic seas to endeavor to complete the survey of some 700 miles of the coast forming the shores of a large bay which Parry, in 1822-3, with two ships and their crews, failed to accomplish. This expedition, which proved successful, was the beginning of a series of voyages of discovery. Dr. Rae was the first man to bring information of the fate of the Sir John Franklin expedition, for which he received a reward of $50,000. He was engaged in several surveys for telegraph lines in the northern part of the American continent. He was a Fellow of the Royal Society, Fellow of the Royal Geographical Society, honorary correspondent of the Geographical Society of America and honorary member of the Natural History Society of Montreal. He was awarded some years ago the Founders' Gold Medal of the Royal Geographical Society. His publications are very few, consisting of a number of short papers on the Esquimaux and other subjects, a brief narrative of an arctic expedition made in 1846-7, and brief reports of his other expeditions addressed to the Royal Geographical and other societies.

NEW PUBLICATIONS.

AUGUST MAGAZINES.—Fiction and such like material occupy the pages of "Harper's," "Scribner's" and the "Century" for this month, although there may be mentioned "Cup Defenders, Old and New," in the "Century," which gives elevations and cross-sections showing the development of the modern type of racing yachts. In contrast with the magazines mentioned the "Cosmopolitan" has two articles of direct engineering interest. The first one is on "The Intercontinental Railway," and is by Mr. W. D. Kelley, who succeeded Mr. J. Imbrie Miller as the chief of the corps which ran a continuous transit line from Quito, 14 miles south of the equator, for a distance of 1,436 miles. This article outlines the proposed road, gives a considerable amount of descriptive information more or less closely connected with the project and is illustrated. The second article in the "Cosmopolitan" describes more particularly the sewage farms of Berlin, under the popular title, "How to Make a City Cholera-Proof." It was written by Mr. Poultney Bigelow, who ends by outlining a scheme for converting some of the "dreary sand wastes" of Long Island into a "very paradise of fruits, flowers and vegetables" by irrigating it with the sewage of New York city.

Like many other enthusiasts, Mr. Bigelow passes entirely over the most difficult part of the problem, saying nothing about the means of crossing the East River, further than that the sewage would be conveyed to a dozen points on the east side of the town and "pumped off night and day, by means of powerful engines, through suitable pipes, out onto the city farms"—all as if there were no river to cross. In a popular way, however, the article will doubtless do much good, in calling public attention to modern sanitary methods, but lest the engineer should be disappointed by finding the figures rather old it is well to add that the latest of them are for 1887.

The word cholera is much relied upon in these days to catch the eye of magazine buyers. The "North American Review" has an article on "How Cholera Can be Stamped Out," by Dr. Ernest Hart, Editor of the "British Medical Journal" and other English publications. Dr. Hart reviews the cholera experience of several countries and concludes that, in Europe at least, water is the chief agent for the spread of cholera, and that its purity should be aimed at, together with purity of soil and air.

The "Review of Reviews" has a sketch of the life of the late Senator Leland Stanford, by Dr. Albert Shaw, which contains some interesting matter relating to the building of the Central Pacific Railway and the founding of the Leland Stanford, Jr., University. "Protection from Lightning" is discussed in the "Popular Science Monthly" by Mr. Alex. McAdie, who reviews some of the latest discussions on the subject and closes with recommendations to those who propose to erect lightning protectors. For a conductor iron or copper of rod or tape form, preferably the latter, is favored. Mr. Geo. Iles contributes a suggestive article to the same magazine on "Success with Scientific and Other Meetings," and an illustrated article entitled "Why a Film of Oil Can Calm the Sea" is contributed by Mr. G. W. Littlehales, Chief of the Division of Chart Construction of the U. S. Hydrographic Office.

SOCIETY PROCEEDINGS.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—As the proceedings of the annual convention from Division A of the International Engineering Congress, these proceedings are reported elsewhere with those of the other divisions of the congress. The business meeting of the Society was held Aug. 2, Mr. Metcalf, President, in the chair. After the reading of the new rules for nominations for officers the report of the Committee on Rail Sections was read by Mr. R. W. Hunt. The report referred to the reconciling of the various conflicting ideas respecting rail sections and recommended a form of section with 42% of metal in the head, 21% in the web, and 37% in the base; 12 ins. top radius; five-sixteenths in. top corner radius, 13° fishing angle, and width of head varying slightly with weight of rail. Mr. Geo. S. Morison, in a minority report, favored a uniform width of head. The report was accepted, and the committee discharged, a resolution being later carried, on motion of Mr. Prout, recognizing the important work which the committee has done.

The subject of the appointment of a committee to report upon a proposed code of ethics was then taken up, and a statement of the Board of Direction, giving arguments for and against, was read by the President, and is printed in another column. The recommendation of the Board was that no such committee be appointed. Mr. Trautwine and Professor Merriman spoke in favor of such a committee, and Mr. Moore and Mr. Cohen against it. The latter said that while the adoption of such a code, even if the committee was appointed and reported in favor of it, was most improbable, it seemed a matter the agitation of which might be dangerous to the interests of the Society, and the profession. Mr. A. Fteley spoke strongly against such action, showing that many cases would probably not be covered by the rules, and would therefore have to be referred to the Board of Direction. In his 25 years' experience in this country as engineer of works and consulting engineer he had met with many cases where the conduct of engineers had been questioned, and in most of these cases without any grounds. Very many such cases arise between engineers and contractors, and occur in malicious opposition to the election of engineers as members of the Society by means of letters alleging certain misconduct, which are generally found to be false charges. He thought a man should follow out his own ideas of right and duty, and stand of fall thereby. The matter was then put to the meeting and defeated by a vote of 11 for to 54 against the appointment of such a committee.

The members of the various geographical districts then assembled in groups to select members of the nominating committee from such districts.

At the meeting on the evening of Friday, Aug. 4 the President, Mr. Metcalf, read the annual address, which was brief but well prepared, dealing with the growth and development of engineering since the early days of the history of the world rather than with any recent modern development. He referred to the roads, irrigation works, etc., of the Egyptians, the Romans and the Jews, and pointed out that the advancement of engineering during the past 400 years was epitomized in the great naval parade at New York in April, 1893, when the caravels of Columbus and the great modern steamships were seen side by side. Future development by such influences as railways in Siberia and central Africa and our interoceanic canal were also referred to. Engineering embraces the proper employment of labor on the one hand and of capital on the other hand. The engineer is but the high development of the mechanic, and stands between labor and capital, being just to the former and honest to the latter.

On motion of Mr. Macdonald a resolution was passed expressing appreciation of the work and attention of the Executive Committee of Associated Engineering Societies.

After the address members of the Nominating Committee were voted for. The present arrangement appears to be clumsy and awkward in the extreme, the individual selection of names by circular amounts to little, and the names finally selected are picked out by the few members of each geographical district who are present at the convention, and the two names suggested by each group were voted upon by the limited number attending the final meeting. There seems to be no good reason for such a complication, and no good reason why members should not select their own choice for president, leaving the Nominating Committee to then select the four or five names having the largest number of votes to be balloted upon by the entire membership. The Nominating Committee finally chosen at this meeting is constituted as follows:

District 1—Geo. S. Greene, Jr.
District 2—Clark Fisher.
District 3—Frederick Brooks.
District 4—Adolphus Bonzano.
District 5—C. Strobel.
District 6—J. B. Johnson.
District 7—John McCloud.

INTERNATIONAL ENGINEERING CONGRESS.—We gave last week the report of the proceedings of the opening session on Monday, July 31. The following are reports of the proceedings of the several divisions of the congress. Abstracts and reprints of the more important papers will be given in Engineering News as space can be spared for them. It is the intention to have the complete papers presented before each division published separately, with the discussions upon them, but some time will, of course, elapse be-

fore they are ready for delivery. For the convenience of those of our readers who may wish to secure copies we will say that the papers in Division A, Civil Engineering, will be published by the American Society of Civil Engineers, 127 East 23d street, New York City; those in Division B, Mechanical Engineering, by the American Society of Mechanical Engineers, 12 West 31st street, New York; and those in Divisions C and D, Mining and Metallurgical Engineering, by the American Institute of Mining Engineers, 13 Burling Slip, New York City. No arrangements have been made concerning the publication of the papers presented in Division E, Engineering Education. The papers in Division F, Military Engineering, were printed by the Government for use at the meeting. It is expected that they will all be embodied in the report of Maj. Clifton Comly, U. S. A., in his official report on the Columbian Exposition, which will be published as a public document and will then be obtainable through the usual channels. Arrangements for the publication of all the papers and discussions in Division G, Marine and Naval Engineering, have been made with the firm of John Wiley & Sons, to whom orders for the volume should be addressed. No arrangement for the publication of the papers and discussions before the Aerial Navigation Conference has yet been completed, but it is expected that they will be made available.

Division A, Civil Engineering.

The first paper presented on Tuesday, Aug. 1, was an interesting one by Mr. Geo. S. Morison, on "The Continuous Superstructure of the Memphis Bridge," a brief abstract of which was presented by the author. The discussion was opened by Mr. Geo. H. Thomson, who referred to the wear and strains due to vibration, which strains do not appear upon the strain sheet. Sir Benjamin Baker said that in examining a number of wrought iron bridges which had been in service for many years he found the greatest wear was not where it might have been expected from the strain sheets. Where trough floors were used and had not been securely attached to the web of the girders, they had worn the web plates deeply by their constant motion. Mr. Moore referred to the uselessness of small rollers for bridge bearings, as they get clogged by dirt and cannot move, causing severe strains in superstructure and masonry. In one case these strains on a pier caused the separation of the coping. He recommended Mr. Morison's plan of using sections of cylinders of large diameter, as described in our issue of July 27. Mr. Morison stated that in bridge superstructures there are two sources of motion: one is the change of length due to strain, which is legitimate; and the other is the lost motion in connections, which should be prevented in every possible way. In consequence of piping and other defects in pins, he now has them always bored through the center. Mr. Macdonald said he thought the practical limit of span for this class of structure had been reached in the Memphis Bridge, as with the very large connections there is difficulty in transportation, since careless handling may throw pinholes as much as ¼ in. out of line, although in the shops they were bored fair and square. Two papers were then read by title: "The Enlargement and Improvement of the North Sea Canal of Holland (Amsterdam Ship Canal)," by A. E. Kempees; and "Notes on Projects for the North Sea Canal, from 1629 to 1893," by A. Huett.

In the discussion of the paper by Mr. Henry Faija on "The Manufacture and Testing of Portland Cement," Mr. Griffith, an English engineer who has long been engaged on marine harbor work, in which the use of Portland cement was an important feature, said that of late years there has been a tendency to use a light burnt cement to facilitate grinding, but this is a very unsafe practice. Standard tests should be as simple as possible, so that they may be carried out by engineers where laboratory appliances are not available. The sand test is not generally used in England, though used in Germany. Mr. Whittemore did not approve of the hot test, and thought the compression test of cement more important than the tensile test, as the material is rarely subjected in service to tension strains. Mr. Lesley stated that nobody can tell just the moment when the chemical action of setting takes place, and that there is a period during setting when any strain upon the cement will retard or prevent setting. He considered it better to spread the mud on the floor and cut it by hand than to make it into bricks in a brick machine, as the latter makes it too dense for good burning. The sand test shows the quality of the sand used. Dr. Coleman Sellers has used a sand blast test for abrasion, in connection with cement to be used for the Niagara water power tunnel, where the water has a considerable fall. Captain Black said that at St. Augustine, Fla., he had used a concrete of 1 part good cement, 2 parts sand, almost all silica, and four parts coquina gravel (small shells) in place of stone. Concrete made thus and remaining in air was in perfect condition after two years. That laid in water was soft and worthless, and that made in air and then placed in the water was also soft. He thought this to be probably the case with many concrete foundations, but as the margin of safety is so large it is improbable that this will ever be found out. On a concrete seawall of Resendale cement, in Florida, where puddles of seawater on the top were exposed to a very hot sun, the concrete under the puddles was so soft that a knife could be pushed into it, but on face of the wall, where the water had no lodgment, the skin of the cement remained quite hard. Where a concrete face was exposed to the action of surf it was abraded by the action of the sand in the surf. The interior of a cement test pat will harden later than the exterior. Sir Benjamin Baker said that in spite of the vast amount of literature on the subject there is still an entire lack of accord between engineers as to the use of cement. On the Manchester Ship Canal the tensile strength of cement for dock walls was specified at 300 lbs. per sq. in., but on the works of the Liverpool water-works is was specified to be 80% higher. Yet the engineers of both works were entirely satisfied with the cements and the results in the work. The tensile strains in concrete masonry are very small, but there may be severe shearing strains. He described an autographic machine for recording a diagram of the setting of cement pats.

The following papers were also presented: "The Testing of Portland Cement and the Development of the Cement Industry in Germany," by Max Gary; "Bridge Superstructure and Foundations in Nova Scotia," Martin Murphy; "Improved Method of Constructing Foundations Under Water by Forcing Cement Into Loose Sand or Gravel by Means of Air Pressure," F. Neukirch; "Topographic Surveys," Herbert G. Ogden; "Terrestrial Magnetism in North America," C. A. Schott; "Historical Notes Upon Ancient and Modern Surveying and Surveying Instruments," H. D. Hoskold; "Fundamental Units of Measure," T. C. Mendenhall; "Recent Experience on the U. S. Coast and Geodetic Survey in the Use of Long Steel Tapes," R. S. Woodward.

The first proceeding on Wednesday, Aug. 2, was the presentation of abstracts of the following four papers on the steel question: "The Treatment of Metals for Structural Purposes," by James Christie; "The Use of Basic Mild Steel as Material for Construction in Germany," by C. Weyrich, Germany; "A Proposed Method of Testing Structural Steel," by A. E. Hunt; and "The Use of Mild Steel for Engineering Structures," by George C. Mehrtens, Germany. These papers were discussed together. Mr. C. C. Gleim stated that Mr. Weyrich and Mr. Mehrtens are among the leading German advocates of the use of mild steel. Under the German specifications material is rejected which exceeds the higher figures allowed, as such material is likely to be deficient in elongation and ductility. Mr. Buck was in favor of reaming all punched holes after assembling, and thought a slight countersink for the sharp edges of the holes would prevent cracks from starting. Mr. Don J. Whittemore mentioned a case where a long steel bridge member, mounted on the cars, fell off and was broken; he queried whether this could have happened with a wrought iron girder. Mr. Geo. H. Thomson, however, said it was important to know whether the steel was basic open-hearth or Bessemer, or acid open-hearth or Bessemer, and whether it had not been injured in punching. Mr. Geo. H. Morison referred to the case of a schooner striking the steel drawspan over the St. John's River, Florida, and the only damage was the bending of a vertical post which was struck by the bowsprit with such force as to break the latter where 26 ins. thick. He thought the post would have been more badly damaged if of wrought iron. Mr. Robert H. Moore said that his fear of mild steel and of screw threads on steel had disappeared. In one case he used iron anchor bolts for a steel structure owing to the prejudice against steel, but some of the rods broke at or near the screw thread. The rods had been upset and annealed. Mr. Wm. Metcalf said that we hear much of making steel mild by a low tensile strength, but it is in fact "rotten" when too low in tension and too long in elongation. By melting too low to reduce the phosphorus, or by blowing too low to reduce the carbon, the steel is damaged by the excess of hydrogen and nitrogen which is blown into it and cannot be eliminated. No steel should be below 15 carbon, and may run up to 20 and 23. In his works he has boilers of 25 carbon steel which are superior to any so-called mild steel. Engineers should rid themselves of the idea that the maximum strength means maximum safety. The danger in the use of steel is largely increased by making it too mild. The damage in melting is not due to the elimination of phosphorus, but to the consequent introduction of hydrogen and nitrogen.

The following papers were also presented: "American Grain Elevators," by E. L. Heidenreich; "Manufacture and Use of Paving Brick," by D. W. Mead; "Carbon and Its Uses in Electrical Engineering," C. M. Barber; "Inland Transportation," Capt. F. A. Mahan; "The Improvement of Harbors on the South Atlantic Coast of the United States," Capt. W. M. Black, U. S. A.; "The Electric Light Plant of Guadalajara," R. M. de Drozarena, Mexico; "Practical and Aesthetic Considerations in the Laying Out of Cities," F. Stubben; "The Relative Merits of Working Hoisting Machinery by Steam, Water and Electricity," by Mr. G. A. Goodwin. There was little discussion, but in some remarks on the paper on paving brick Mr. Mead said that the best paving brick are vitrified brick, but that unvitrified brick has given good results at Bloomington and elsewhere. Mr. C. C. Gleim then read abstracts of three papers sent in by Mr. Fulscher, Chief Engineer of the North Sea & Baltic Canal, dealing with the canal, the lock at the Baltic end, and the sand dams or embankments.

There was very little discussion of the papers presented Thursday, Aug. 3, as the number of the papers on the list necessitated prompt action. The first paper was on "The Gages of Railway Track in General, with Special Consideration of Narrow Gage Railways," by E. A. Ziffer, Germany. Mr. Prout and Mr. Crowell pointed out that the paper makes assumptions which are not founded on fact as to the economy in cost of operation and equipment, and that the subject is one which is of little importance in this country owing to the recognized advantages of a uniform gage. Mr. Tratman presented a written discussion showing that the author had not classified the railways at all, but had considered ordinary street and industrial railways all together, although the gage of industrial railways in factories, warehouses, plantations, etc., is a question of convenience only, and has no relation to the general question of railway gage. The following papers were also presented: "Transmission of Power in Operating Cable Railways," by Robert Gillham; "A New Method of Calculating Cross Sections of Roads and Railways," by F. S. Ribeiro, Portugal; "Destructive Features and Advantages of American Locomotive Practice," D. L. Barnes; "Railway Signaling," by G. Kecker, Germany (in discussion of this paper Mr. Hardy pointed out that a system of signaling is quite distinct from the method of operating the signal system, and should be so considered); "Surveys for Railway Location," by F. A. Gelbcke, Germany (in discussion of this paper Mr. Hardy said that the method proposed was complicated and expensive; in the German practice the line is not staked out until after it has been laid down on a topographical map, while in this country we put more reliance on the experience and skill of a locating engineer); "History of the Conversion of the River Clyde Into a Navigable Waterway, and the Progress of Glasgow Harbor from Its Commencement to the Present Day," James Deas, Glasgow; "The Limits Attainable in Improving the Navigability of Rivers by Means of Regulation," by H. Engels, Germany; "The Development of Quay Cranes in the Port of Hamburg," C. Nehls, Germany; "The Plant of Maritime Commercial Ports of France," by H. Despres, France; "Railways in New South Wales," T. F. Birrell; "Study for Railways from Guadalajara to the Pacific Ocean," S. V. Pascal, Mexico; "Railways of Mexico," E. B. Basave, Mexico; "The Rearrangement of the Railway System of Cologne," F. Lohse, Germany; "Comparison of Modern Engine Loading with Standard Specifications for Spans from 10 to 200 Yards," by C. D. Purdon. In the evening a paper on "American Methods of Erection of Bridges and Structures," illustrated by stereoptican views, was presented by Mr. F. W. Skinner.

A considerable number of papers were presented by title, with little discussion, on Friday, Aug. 4. An abstract of the paper on "Description of the Lower Weser and Its Improvements," by L. Franzius, Germany, was read, and particulars given of the proposition to deepen the river by stirring the sandy bottom and allowing the current to carry away the sand, as noted recently in our columns. Captain Black, U. S. Engineers, in discussion referred to the early use of scrapers on Western rivers, and to the use of piles to cause scour. Dynamite charges had been used for ocean bars, and deeply loaded ocean steamers for the same purpose by means of their propellers, but in all such cases the sand was redeposited a short distance off. Two other harbor papers were: "A Brief Account of the Building of Leixoes Harbor," by A. J. N. Soares, Portugal, and "Method Used to Secure the Stability of a Quay Wall at the Port of Altona, on the Elbe, which Has Shifted its Position After Completion," by B. Stahl, Germany.

The four following papers on related subjects were then read by abstract: "Purification of Sewage and of Water by Filtration," by H. F. Mills; "The Sewerage System of Milwaukee, and the Milwaukee River Flushing Works," by G. H. Benzenberg; "Experience Had During the Last 25 Years with Water-Works Having an Underground Source of Supply," B. Salbach, Germany; "Some Questions Concerning the Filtration of Water," by W. Keummel, Germany. In discussion Mr. Chas. B. Brush said that the paper on underground sources of supply was an extremely important one, and would be still more valuable had particulars been given of the character of wells used and the methods of sinking them. There is a great difference in the quality of water from a stream and that from subterranean strata underlying the stream. At Princeton, N. J., wells driven in the bed of Stony Creek, a polluted stream, flowed pure water which

rose about 3 ft. above the water level of the stream. A similar case occurs at Jamestown, N. Y. Mr. Tribus referred to the water-bearing strata underlying the Gulf of Mexico and the Gulf coast. Some of the fresh-water springs in 100 to 300 ft. of salt water are noticeable on the surface. At Pensacola there are wells near the water line and also about a mile back. The flow is from a stratum of white gravel mixed with white sand and overlaid by blue clay. Mr. Don J. Whittemore referred to the water-bearing strata underlying the James River Valley in Dakota. In reference to Mr. Benzenberg's paper he said that before the river flushing was put in operation, the Chicago River (black and foul as it is) would have been considered clean by comparison with the Milwaukee River, which received sewage and the refuse from factories, etc. It is not often that an engineer's work is recognized and appreciated by the public in 24 hours after its completion, as was the case at Milwaukee when Mr. Benzenberg's flushing system was put in operation. (The system has been described and illustrated in Engineering News.) Mr. Rudolph Hering said that too much stress is laid on the utilization of sewage, which is really a very secondary question compared to the main question of purification. His investigations showed that sewage is not purified by flowing in water, but is merely diluted. He considered filtration the best system of purification for sewage. The chemical treatment plant of the sewage of the World's Columbian Exposition only removes about half of the organic matter, taking the matter held in suspension, but leaving that in solution. Mr. Allen Hazen said the proportion removed was 60%, but was mainly the matter in suspension, as stated. Mr. Benzenberg said the Laurence experiments on sewage purification had shown that filtration can be made entirely successful if the work is not forced, but nature allowed to take its time for slow and thorough operation. In practice the plant must be of greater scope and capacity than the carefully managed plant of an experiment station. Mr. Mills, referring to the centrifugal pumping plant at Milwaukee, said that in the metropolitan sewerage system of Boston it had been found cheaper to put in two centrifugal pumping plants than to carry a gravity sewer to one reciprocating pumping plant.

The following two papers were then read by title: "Possibility of Increasing the Water Supply from the Soil for Purposes of Irrigation and of Augmenting the Flow of Rivers," by G. H. O. Volger, Germany, and "On the Distribution of Water in the City of Mexico," by L. Salazar, Mexico. The meeting then adjourned.

Division B, Mechanical Engineering.

The session of this branch of the Congress on Monday forenoon was devoted to routine business. On Tuesday morning the report of the Committee on "Uniform Methods of Testing Materials" was presented by Mr. Gus C. Hening, and a resolution was adopted recognizing the advantages of international conferences for the discussion and adoption of uniform methods of testing and asking the U. S. government to take action to secure representation in such conferences.

The final report of the Committee on Standard Tests for Locomotives was then presented. The preliminary report was published in our issue of May 19, 1892. The final report contains considerable additional matter, and changes many recommendations of the preliminary report.

Prof. W. F. M. Goss, of Purdue University, presented a paper describing shop tests on the locomotive testing plant at Purdue.

The next paper read was by A. Mallet, of Paris, entitled "Locomotives Operating by Total Adhesion on Curves of Small Radius." He gave an extended history of European locomotives specially designed for sharp curves, and advocated the articulated compound engines invented by himself as the best solution of the problem thus far presented. A paper in a similar vein was by A. von Borries, of Hanover, Germany, on the "Development of the Compound Locomotive." Mr. von Borries, however, gave more credit to the work of American designers than did Mr. Mallet. Another paper by a foreign engineer closed the day's program. It was entitled "Experiences in the Construction and Operation of Rack Railways," and gave a very full account of experience with the Abt system, with some notes also concerning other systems which have competed with it.

On Wednesday a half-dozen papers by German engineers were taken up. In the first, on "The Operation of Centrifugal Machinery," Prof. Gustav Herrmann, of Aachen, who has been at work for some years on a revision of Weisbach's "Mechanics," gave a mathematical discussion of the theory of centrifugal machines, such as cream separators, dryers, etc., and described some recent improvements in machinery of this class. The next paper, by R. Kohfahl, of Hamburg, described the Nagel & Kaemp dust-collector, a German improvement of the Prins machine extensively used in American flour mills. Mr. C. Pieper, of Hamburg, was the author of the next paper, which described a German "fare indicator and receipt controller," invented for use on cabs and christened the "taxameter." Recent improvements in the manufacture of insulated cables for electric currents were described in a paper by Emil Guilleaume.

The remaining two papers treated of metering devices; one described the Schinzel water meter, a form of the old "inferential" or rotating fan meter, which was superseded by positive measuring meters years ago in this country. The other paper described a steam meter invented by Franz Seiler, of Mannheim, Germany, and patented in the United States a year ago (No. 481,287).

Thursday's session was devoted to a series of steam engineering papers, beginning with a paper by Prof. Dwelshanvers-Dery, of Belgium, on the theory of the steam engine. This was followed by a paper by Chas. T. Porter, in which that noted advocate of high-speed engines appeared in a new role, advocating the limitation of piston speed to not more than 600 ft. per minute with engines under 3-ft. stroke. Mr. Mansfield, of the Buckeye Engine Co., opened the discussion, upholding Mr. Porter's position; but the advocates of higher speed were also heard from. Mr. F. H. Ball, of the Ball & Wood Co., read a paper on compression as a factor in steam engine economy, presenting the theory that the most economical compression curve varies with the form of the expansion curve.

A paper by Prof. J. E. Denton described tests on a crank and flywheel pumping engine in use on an oil pipe line at Laketon, Ind., which showed a duty of over 137,000,000 ft.-lbs. per 100 lbs. of coal. Tests with and without jackets showed a gain of about 8% in economy by use of the jackets. This was followed by a voluminous report of tests on the power plants of the Twin City Rapid Transit Co. by Messrs. W. A. Pike and T. W. Hugo. There was a brisk discussion over this paper by Messrs. Geo. H. Barrus, Henry M. Smith, Geo. I. Rockwood and F. A. Scheffler.

The remaining papers of the session were: "An Evaporative Surface Condenser," by Jas. H. Fitts; "A Coal Calorimeter," by Geo. H. Barrus, and "Anhydrous Ammonia Gas as a Motive Power," by T. W. M. Draper. The topic of the last-mentioned paper has been recently discussed by the author in Engineering News.

The concluding session on Friday morning opened with a paper by Wm. L. Chase, discussing the application of the Dewey decimal system of classification to the use of engineers, for arranging pamphlets, clippings, etc., in a form convenient for reference. Thos. H. Brigg, of Bradford, England, then read a very interesting paper on "Haulage by Horses," which was discussed at considerable length. The author's contention is that in going down hill or on a level the load should lift a part of the horse's weight. In going uphill, on the other hand, the horse should carry part of the weight of the load to enable him to work with the greatest ease. "The Refrigerating Machine of To-Day" was the title of a paper presented by C. Linde, of Munich, Germany; and Mr. Fred. H. Daniels, of Worcester, Mass., gave a history of the development or wire-rod rolling mills in the United States. The other two papers of the session were: "Notes on the Drainage Machinery of the Netherlands," by A. Huet, of Delft, Holland, and "Technical Education in the United States," by Prof. R. H. Thurston. The latter author acknowledged his indebtedness to the series of articles which have appeared in Engineering News. Considerable discussion followed on the topics brought up by Professor Thurston's paper, and in the course of it the following resolution was presented by Mr. H. F. J. Porter and adopted by the meeting:

Resolved, That the Council of the American Society of Mechanical Engineers consider the advisability of recommending to educational institutions a uniform system of technical education; and that it endeavor in connection with the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Institute of Electrical Engineers and such other organizations as seem to be proper, to carry out such a uniform system as is deemed right.

Resolved, That the Council consider the advisability of recommending that technical institutions give the degree of Bachelor of Engineering only, and of establishing a body which would have the authority to give the final title, "Engineer." That it endeavor in connection with the other societies above named, to carry out such a program.

Division C, Mining Engineering.

This division held a joint session with Division B, Mechanical Engineering on Tuesday, Aug. 1.

The papers presented on Wednesday, Aug. 2, were all on the subject of ventilation and safety in mines, as follows: "The Detection and Measurement of Firedamp in Mines," Prof. G. Chesneau, France; "The Hydrogen Oil Safety Lamp," Prof. Frank Clowes, England; and "Experimental Investigations on the Loss of Head of Air Currents in Underground Workings," by D. Murgue, France. These were followed by some discussion on the papers on ore deposits presented at the previous meeting.

There was a rather small attendance on Thursday at this division, at which the following papers were presented and discussed: "The Bertha Zinc Mines," W. H. Case; "Handling of Large Quantities of Iron Ore," by John Birkinbine; the discussion was largely as to the use of the steam shovel in stripping and handling ore. "Improvements in Ore Dressing," by O. Bilharz, Germany; in the discussion of which the Luhrig system of coal washing plant employed in Europe was described. "An Improved Hanging Compass," by G. R. Johnson; and "Electricity in Mining," by F. O. Blackwell, an abstract of which we shall publish later.

Two interesting papers were presented on Friday: "A Furnace with Automatic Stoker and Traveling Grate Especially Adapted to Burn the Small Anthracites," by Eckley B. Coxe; and "Tests of Hydraulic Materials," by H. Le Chatelier, France. The grate designed by Mr. Coxe has transverse bars with corrugated faces, attached to a chain belt traveling across the furnace, one end of the return side of the grate being depressed to dip into a water tank for the ashes. The paper by Mr. Le Chatelier pointed out that while great advantages have been derived from the complete investigations and tests made, the growing multiplicity and complexity of the proposed tests render them impracticable outside of laboratories, and leads to a restricted instead of an increased use of such tests. The paper was prepared for the purpose of enlarging the use of methods of testing by opposing their abuse. The following tests were recommended: 1, Fineness of grinding, according to the residue from a sieve of 5,850 meshes per sq. in.; 2, Resistance to crushing of cubes 2.8 ins. or cylinders 1 in. in height and diameter, composed of 1 cement and 2 sand; 3, Invariability of volume in boiling water; 4, Rapidity of setting of mortar, 1 cement to 2 sand; 5, For the detection of aluminates, to foretell the stability of cement in air or sea water.

Division D, Metallurgical Engineering.

The following papers were presented by title and in abstract: "Summary of American Improvements and Inventions in Ore Crushing and Concentrating, and in the Metallurgy of Copper, Lead, Gold, Silver, Nickel, Aluminum and Zinc," James Douglas; "Experiments on the Specific Gravity of Gold Contained in Gold-Silver Alloys," Henry Louis; "The Limitations of the Stamp Mill," T. A. Rickard; "Improved Slag Pots," H. A. Keller; "The Separation of Blende from Pyrites, a New Metallurgical Industry," W. P. Blake. Some of the papers presented on the previous day were also discussed.

Five very interesting papers on the physics of steel were presented on Wednesday, Aug. 2, as follows: "Microscopic Metallography," by F. Osmond, France; "Micro-Structure of Ingot Iron in Cast Ingots," Prof. A. Martens, Germany; "Seggregation and Its Consequences in Ingots of Iron and Steel," A. Pourcel, France; "Micro-Structure of Steel," Albert Sauveur; "Heat Treatment of Steel," H. M. Howe. Three of these papers were illustrated by photomicrographs showing the structure of steel, and some of these from rail sections were of special interest. We shall publish abstracts of some of these papers later. A paper on "Further Observations on the Relations Between the Chemical Constitution and Physical Character of Steel," by W. R. Webster, was presented by title.

The following papers were presented on Thursday: "The Bessemer Process as Conducted in Germany," R. Akerman, Sweden; "The Open-Hearth Process," by H. H. Campbell (a treatise of 167 pages); "Consumption of Fuel in the Taylor Gas Producer Plants at the Aspen and Marsac Mills Compared," by C. A. Stetefeldt; "Electric Welding," by E. C. Moxham; "Iron Alloys with Special Reference to Manganese Steel," R. A. Hadfield, England. Specimens of manganese steel manufactures were exhibited.

Five papers were presented on Friday: "Review of American Blast Furnace Practice," by E. C. Potter; this showed the characteristic features of the practice, dating from the Edgar-Thomson "A" furnace in 1879, which began an era of rapid driving, while later improvements showed that rapid driving is not incompatible with low fuel consumption as had been claimed by English critics. "A New Process for the Production of Pig Iron, Refined Iron, Ingot Metal and Weld Metal," by A. Sattmann and A. Homatsch, Austria. By this process gas is substituted for the usual solid fuel, and the process is divided into four phases: 1, Heating the ore and flux; 2, Reduction of the ore, and carburization of the resulting iron sponge with reducing gas; 3, Melting the carburized iron sponge by the direct combustion of solid fuel; 4, Separation of the slag from the resulting pig iron and refining with oxidizing gases immediately after melting, thereby producing a more or less carburized metal. "Sulphur in Cast Iron," by W. J. Keep; this paper claimed that the injurious effects of sulphur in iron, and in the fuel used, are very much overestimated, as only a small percentage of sulphur can be made to remain in carbonized iron, and it is difficult, if not impossible, to introduce sulphur into it. "Blowing Engines," by Julian Kennedy; "Automatic Valve Gear for Blowing Engines," J. C. Brooks; and "Advance in Pyrometry," by Professor Roberts-Austen, England.

(To be continued.)

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The headquarters of Engineering News on the grounds of the World's Columbian Exposition are at Section K, Aisle 37, of Machinery Hall (central aisle, just west of the large water tank), and at Section U N, Posts 10 to 11 (office No. 9), of the Transportation Building Annex, at the west end of the Great Britain railway exhibit. For the convenience of subscribers and advertisers, it is announced that some member of the editorial staff of this journal may be found at the first-named office, in Machinery Hall, from 10 to 10:25 a. m., of each week day, and from 10:35 to 11 a. m. at the second-named office, in the Transportation Building; as also frequently at other times. Appointments may be made by calling at our downtown Chicago office in the Monadnock Building.

The Engineering Headquarters, at Chicago, are at No. 10 Van Buren St., directly opposite the viaduct leading to the Illinois Central R. R. World's Fair trains, and to the steamboat pier, and but a stone's throw from it. The rooms are large and comfortable, and include reading, writing, smoking and other apartments. The rooms are to be kept open during the Fair by subscriptions of engineers, and all American and foreign engineers visiting Chicago are invited to register and make free use of the rooms during their stay, and to have their mail addressed there. An informal reception is held at these rooms every Monday evening from 8 to 10 p. m.

The International Engineering Congress held in Chicago last week was doubtless the most important assemblage of engineers for the discussion of technical subjects which has ever met. The nearest approach to it in this country was the joint meeting of the American Institute of Mining Engineers, the British Iron & Steel Institute and the Verein Deutscher Eisenhuettenleute, in October, 1890. In the number of foreigners present, especially, and in the variety and extent of the excursions which were taken, that meeting was without a parallel; but the papers read before it were limited to a single department of engineering, whereas at Chicago last week nine different bodies of engineers met simultaneously for the discussion of topics covering (with the exception of electrical engineering) all important departments of the profession's work.

The papers presented before all the divisions of the Congress amounted to over 250, and with some few exceptions were of a high order of merit, considerably above the average grade of the papers presented to the national engineering societies. The attendance at the sessions was remarkably good, especially when the counter-attractions offered by the Exposition are taken into account; the discussions in nearly all the divisions were interesting and well maintained. In fact, the chief drawback was that nearly every division of the Congress had more papers on its program than could be fairly presented and discussed in the limited time of the sessions, and as most of the papers were not in print early enough for distribution prior to the Congress members had scant time to study them and prepare discussions.

In our department of "Society Proceedings" we give in this issue a brief resume of the work done by each division of the Congress, and in the following issues shall publish abstracts or reprints of the papers of most importance to our readers.

The subject of co-operation or confederation of the different engineering societies has been much discussed during the past few years, although lately the matter seems to have been dropped; but last week's engineering congress gives a hint as to a direction in which co-operation might be of value and benefit to all concerned. Why might not last week's congress be repeated, barring the part taken in it by foreigners, every summer? The national societies of civil, mechanical, mining and electrical engineers all hold summer meetings. Why not agree to meet at the same place and the same time, each society holding its separate meetings, and attending to its own affairs precisely as if it met independently?

Such a meeting would, it seems fair to presume, attract a larger total number of engineers than can be brought together by all the societies meeting separately. The joint meeting of all the societies would be a much more important event than the meeting of any one can be; and the much larger opportunities for social intercourse would have their weight in influencing attendance. Of course, as in the Congress last week, the meetings of each society would be open to the members of any other society just as they are now; and members of one society might even be permitted to take part in the discussions of another, though this is by no means an important or necessary part of the program. The advantages of this are readily seen. A member of the Civil Engineers, for instance, is especially interested in steel. While his own society is discussing some paper on a topic for which he does not care a rap, he might visit the mining engineers' or mechanical engineers' sessions and hear something in which he was directly interested. By a little co-operation the various programs might be so arranged that no two societies would consider similar topics at the same hour, and that would largely overcome the objection of those who are members of two or more of the societies that they might desire to attend sessions of different societies occurring at the same time.

On the other hand, while many hold membership in two or more societies, very few can spare the time and money to attend the midsummer sessions of more than one; and this class would doubtless welcome such a co-operation as we have outlined. It is not to be forgotten, also, that the attendance at such a joint meeting would doubtless be so large that reduced rates could be secured from the railways, a matter of much importance in influencing a large attendance.

We freely recognize that there is another side to the question, and that the benefits we have outlined could not be secured without some sacrifices. Nowhere but in a large city or possibly at some of the largest summer resorts could sufficient hotel accommodations be obtained for so large a gathering, and sufficient assembly-rooms be secured for all the meetings. Again, the different societies have somewhat different notions about places of meeting, which are so well known that they need not be stated here, but which might prove somewhat difficult to harmonize. On the other hand, all the societies hold at least two meetings a year. Making one a joint meeting with the other societies, each could hold its other meeting or meetings where it pleased, the mining engineers in the mountains, the mechanical engineers in some of the smaller cities of the country, etc.

Both in the fall of 1890 and in the present year it has been shown that the engineering societies can co-operate with each other when sufficient occasion offers. It is to be hoped that petty jealousies and the "I am better than thou" spirit may not stand in the way of further co-operation, such as we have outlined. To do this would be merely to follow the example of the great scientific associations, such as the American Association for the Advancement of Science, which performs practically all its work by holding sessions in sections.

In our issue of July 20 a correspondent calls attention to the unreasonably low estimate placed by some engineers upon the value of their professional services in bidding for competitive work, and very properly gives this as one reason for the low estimate placed by the general public upon such services. In this connection we note two late cases in point which come to us through our exchanges. One is a city of 10,000 inhabitants calling for bids for the surveys and plans for the complete sewerage of the town. Bids were received from six engineers and engineering firms, and these ranged from $4,000 to $290 for identical work, with a true average of about $1,600. The other case was a call for similar work, with some grading and paving added, from a city of 10,000 inhabitants, and here the bids of ten engineers ranged from $6,240 to $800.

The comment to be made upon this wide range of estimates of the true value of professional services in the cases mentioned is that the bidders were either uncertain as to the amount and character of the work proposed, or that they were in doubt as to the value of any advice they might have to give. As regards the first point, an engineer of experience should be able by personal inspection of the ground and town maps to estimate very closely the mere cost of the field and office work involved; and in any case this cost should not enter as a very important factor in his proposal, for if it were a question of surveys and maps the town authorities could have that work done themselves, at a minimum of expense. What the town wants is the trained experience of an able engineer; the advice of an expert who will give them the best system of sewerage, based upon modern practice, for the least direct outlay of money, and a plan best adapted to prevailing conditions and demands, whatever these may be. It is this service that the town really pays for, and for this service the expert engineer has a right to charge a sum commensurate with his own training and experience. While it is true that some engineers may overvalue their services in particular cases, it is no less true that the man who undervalues his is not a safe investment for any community, and the town authorities who appreciate this fact, in judging of the fitness of competing engineers, will seldom have occasion to regret taking at least a middle course among the bids. The engineer who proposes to work for nothing and pay someone for the privilege either has no practice of his own, and hence probably is lacking in experience, or he intends to gain this needed experience at the expense of the community foolish enough to be tempted by his low bid for services. In either case, as has been said, the cheap engineer is not the kind of an engineer really wanted, and his employment will too often entail upon his employers, in wasteful and useless expenditures, the payment of a sum far exceeding the highest fee of the most competent engineer available. The moral to towns seeking an engineer and to engineers seeking employment is evident—the town cannot afford to pay for the bad work of an inexperienced man, and no experienced and competent engineer can afford to work for mere glory—and he never does.

As announced in another part of this issue, the Committee on Standard Rail Sections of the American Society of Civil Engineers has agreed with substantial unanimity on a series of standard rail sections varying by 5 lbs. per yd. between 40 and 100 lbs. inclusive, which are recommended for general use in a final report to the Society. The sections will be given in our next issue, and pending their appearance we forbear from all discussion of their details further than to say that they are in the line of all recent opinion on that subject and with the report of the former committee on the relation to each other of the form of rails and wheels so far as that report extended, which was

only to the form of the head of the rails. A number of members who were not present at the final meeting of the committee may desire to add qualifying notes to their signatures, but so far as was known at the time of submitting the formal report there was only one dissenting opinion as to one detail only of a few of the heavier sections, among the 13 members of the committee. The main features of the recommended sections are 12-in. top radius, 5-16-in. corner radius (a slight change from the former radius of ¼-in.), vertical sides to both head and base, 1-16-in. lower corner radius and base radii, ¼-in. fillet radii, 42% of metal in the head, and total height equal to width of base. These dimensions are common to all the sections. The most important variable dimension is the width of head, for which a varying ratio of increase was deemed preferable, the sections varying by uniform increments from 1⅞ ins. wide for the 40-lb. section to 2⅝ ins. for the 60-lb.; thence to 2½ ins. for the 80-lb., and thence to 2¾ ins. for the 100-lb. section. A number of companies have already adopted some of these sections in advance of their formal adoption, and the prospect seems good for their now coming into very general use.

That some official tests should be made of the large and varied collection of steam engines which forms the power plant at the Columbian Exposition is an opinion which has been frequently expressed by engineers. The Centennial boiler tests have served as a valuable standard for many years, and are still referred to perhaps more often than any other series of official boiler tests. Some engine tests at this Exposition might serve an equally useful purpose and might settle some questions which are now in dispute. We are glad to announce that the judges of the Machinery department have determined to make some tests, as complete and conclusive as possible, on some of the exhibits in the steam engineering section. Among the judges are Prof. R. C. Carpenter, of Cornell; James E. Denton, of Stevens; and Messrs. Geo. H. Barrus, A. J. Menocal, P. J. McMahon and Prof. W. C. Unwin, the latter of England. The tests will be carried out under the immediate direction of Mr. Geo. H. Barrus. Their scope is not yet determined, but it is expected that the quadruple-expansion and triple-expansion engines will probably receive most attention; and it is proposed to make a test on the De Laval steam turbine, which is attracting so much attention in Machinery Hall.

It is to be hoped that the tests may also be made to shed some light on two other questions which are at present in controversy—the relative economy in steam distribution of the Corliss or releasing valve gear, and some of the newer forms of non-releasing gear which are claimed to show equal economy of steam and which have much advantage in simplicity and durability.

The other question which especially needs attention is the accuracy of the speed regulation effected by the different types of governors, and different forms of valves and valve gear. After a pretty thorough canvas of their exhibits in the power plant, we reached the conclusion that the accuracy of the regulation claimed for different engines varied inversely with the intelligence of the man in charge of the exhibit. The extent of variation in speed which was admitted under such extreme variations of load as are common in electric railway service varied from zero to 3%, and appeared to depend not at all on the design of engine or governor. With some thorough tachometric tests covering the whole range of engine exhibits, both engine builders and users might learn some valuable lessons concerning the accuracy of speed regulation and the arrangement of valves and governors which will secure the best results on engines of each class.

The judges in the Department of Electricity have also arranged for a series of tests, which will probably be made in conjunction with those of the Machinery Department, to determine the efficiency of various dynamos, especially some of the direct-coupled machines. They are to be tested first at the load corresponding to maximum efficiency; second, at a minimum load; and third, at a maximum load. Among the well known names in the list of judges in this department are: Professors Henry L. Carhart, of the University of Michigan; Geo. F. Barker, of the University of Pennsylvania; E. A. Dolbear, of Tufts College; R. H. Rowland, of Johns Hopkins; W. E. Ayrton, of England, and Messrs. Chas. E. Emery and Ralph W. Pope.

THE SILVER STATUS.

He is no careful observer who does not perceive that the world is just now going through a serious and troublesome process of readjustment which no laws nor repeals of laws can either cause or cure, except to make it a little better or worse. It seems to be the nature of the great majority of men to see only one side—

> For poor human nature a pendulum seems,
> Which must constantly vibrate between two extremes.

and accordingly all but a small fraction of the people of the United States are at this moment divisible into two hostile camps, the "silver lunatics," who ascribe all our troubles to a conspiracy against silver, and whose sufficient cure for all troubles is free coinage of silver at the old ratio of 16 to 1; and the "gold bugs," who ascribe all our troubles to legislative efforts to sustain the price of silver, and who claim that the only cause of trouble is not letting silver alone, like iron or copper, to find its own level.

There is no denying that it is difficult to imagine any permanent settlement of the issue, which will take it once and for all out of politics, except a positive choice between one or the other of these alternatives, but whether either will be as effective as its advocates claim, and not bring evil in its train as well as good, is another issue.

The truth is that the trouble which the world in general and the United States in particular is just now going through, and which has been well called " a silent panic," is as different in its nature from all preceding panics as it is in its outward manifestations. We may well believe that it would be much more severe than it is except that business generally is on a sound basis so far as depends on the action of man as distinguished from natural causes. In the ordinary panic the whole trouble arises, and is known to arise, only from the effect of past folly and the reasonable doubts of every business man as to the results of such folly on the status of his neighbors and customers. It is the natural reaction from over-confidence into over-suspicion. Its effect is like a fierce storm, which is unpleasant while it lasts, but soon passes away, leaving the foundations of all things as they were before.

The present trouble arises from the far more serious cause that men doubt not their neighbor's solvency, but the very foundation of credit, the future unit of value. They are compelled to do so, for it is in fact in doubt. We may, indeed, foresee with some certainty, or may soon know by waiting, whether the present gold dollar or silver dollar or something between the two is to be the future nominal standard; but what its future purchasing power will be we cannot foresee, except that we may be reasonably certain that it will not be quite the same ten years from now as it was ten years ago. The effect of such a disturbance, therefore, is more like an earthquake than a storm. It not only creates temporary disturbance, but also creates reasonable doubts as to what is to come after it. Fortunately our financial edifices have been so strengthened of recent years that they can stand earthquakes better than they used to stand storms, and we may count with confidence on there being a foundation left us after it is all over, whether it is precisely the same or not. But it is folly to claim that there is no cause for the present disturbances except the folly of man, or that, if our particular panacea is adopted, all will certainly be well.

There is a great cause for the present troubles in a readjustment of values and a disturbance of financial foundations such as the world has never seen before. We should therefore look with patience on those who differ with us and avoid cocksureness, for it is not likely that any conceivable readjustment will be an ideally just one. It is far more likely to involve considerable undeserved losses to some classes of men and considerable unearned profits to others. The one saving fact is that neither the profits nor the losses need be so large as to be of serious or lasting moment, but there is naturally a struggle to see "who shall be which."

The situation in a nutshell is this: From the remotest ages until about 20 years ago silver and gold have been produced in about equal annual values and the total existing stock of each has had about equal value, so that the ratio of one to the other has remained sensibly constant at 15 to 16 to 1. The gold prices of silver are of record for about 300 years, and the fluctuations have been too small to have any significance. It is probable that we owe this constancy in recent years (though we were not aware of it at the time) to the timely discoveries of gold in California and Australia which for some 30 years sensibly increased the relative value of silver to a little above its historic ratio; and that except for this fact our present disturbances would have begun 30 or 40 years earlier.*

But in the recent years the product of gold has fallen somewhat, and, though it has been lately increasing again, seems to be settling down to a moderate and nearly constant production of $120,000,000 to (possibly) $150,000,000 per year, with little chance of ever increasing the latter total, while the production of silver has increased apace, from only one-fourth of the gold production of 1853-7, when the latter was at a maximum and silver about a minimum, to nearly twice the gold production in 1892. In other words, the yearly output of silver has increased by leaps and bounds to nearly fivefold that of 1853-7 and to nearly threefold that of 1863-7, with every promise of indefinite further increase from known and seemingly inexhaustible sources of supply by steadily improving metallurgical processes. The inevitable result has followed. Silver has fallen heavily, and what has heretofore constituted nearly half of the world's circulating medium has become discredited as such, and is rapidly passing out of use, in spite of unprecedented efforts to maintain its price by law.

This is a tremendous fact. It certainly is a serious misfortune to the world, and it may possibly lead to greater ones than have yet appeared. It is true that the more civilized nations of the world, including the United States, have for some years had practically a single gold standard, and have found gold enough for their needs, but the modern world is practically a financial unit and growing daily more so. If silver is to be permanently unstable, countries which now use silver only must have gold, at least enough for yardstick purposes. That they can be supplied without some appreciation of gold is at least doubtful, and appreciation of gold means a temporary increase in the wealth of creditors and those who have at the expense of debtors and those who have not, which is the reverse of what is desirable if there is to be any inequality. After values have once readjusted themselves it makes no difference to any one what is called a dollar. Permanency of mean purchasing power is the great desideratum, by universal admission.

But does not this admission give away the whole case in favor of silver? Granting what may or may not prove to be the fact, but is very likely to, that the inevitable result of accepting the single gold standard is that its value and purchasing power will slowly appreciate, which is the lesser evil, to have a yardstick of values which slowly grows longer, or one which rapidly grows shorter? The one certain fact is that we cannot continue to use both at once. The more truth there may be in the claims of the silver men that gold is appreciating, the more certain it is that we must choose in the end between one and the other, and the choice will only grow the harder the longer it is postponed. Moreover, it is not as if we were now free to choose between one and the other. We are now using one only, and that by much the most stable of the two. The nominal joint use is a mere fiction of the law. The real question is whether we shall abandon the one we now have, which is much the more stable of the two, and turn to a new one which we can make in the beginning whatever we please (by coining silver at a revised ratio), but which is certainly unstable.

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*Mulhall, in his "Dictionary of Statistics," gives the total production from 1493 to 1888 (396 years) in millions of pounds sterling, as 1,602 gold to 1,944 silver. Prior to 1800 the best estimates indicate that the silver values of the whole world were from two to three times that of gold, but in Europe only the proportion has always been about even, until about 1850, when gold began to exceed largely in Europe. The total gold stock of the world is now estimated at over $6,000,000,000.

It is that instability which creates the silver problem, not the fall in value. If we could only be reasonably sure that that value would stay constant at any ratio whatever, we should by universal agreement accept that ratio for coinage, and the silver issue would disappear. But is there the slightest rational ground for believing that silver production will not hereafter as heretofore rapidly increase if the price is kept up?

M. Leroy Beaulieu discusses this question with great ability in a recent issue (July 1) of the "Economiste Francais." M. Beaulieu was about the only man in France who both saw the truth and told the truth about the Panama Canal, and he is one of the ablest of living economists. He reaches the conclusion that silver is inevitably destined to fall still further—to, perhaps, 33, and probably not much over 40 cts. on our present dollar, until its increasing use in the arts and for small coinage or decreasing production or both arrests its fall. He gives the following comparative figures of yearly production, taking five francs to the dollar and coinage values:

	Gold.	Silver.
1853-7	$160,000,000	$44,000,000
1858-62	.....	53,400,000
1863-67	.....	68,800,000
1883	98,800,000	.....
1892	135,400,000	203,600,000
1896-8 (estimated)	160,000,000	300,000,000 to 400,000,000

The last estimate for silver is given as "beyond doubt, if the nations of the world, or one of the great nations, were to leave open their mints to the coinage or purchase of silver." The use of silver in the arts is stated as only $8,000,000 in the United States and little more than five times that in the entire world. In view of these facts what other conclusion can be reached than M. Beaulieu's that "an end must be made to the disturbing efforts to sustain a material which the immensity of its production has condemned to degradation"?

In regard to the gold supply few men's opinion is more likely to be sound than M. Leroy Beaulieu's, and he has already shown that he is fearless and honest in proclaiming his opinions. He says as to this, perhaps too hopefully, but we are sure honestly:

> As to the pretended rarity of gold, we have often said that there is no reason to be alarmed. Without mentioning other countries, Southern Africa can furnish an increasing quantity of gold.

He then gives the above figures and estimates for an increasing output of gold. There is this in favor of his conclusion, that metallic currency is less and less used as the direct medium of exchange. But on the other hand, it must be remembered that there is no other country in which checks or bank bills are so largely used, by the free choice of the people, as in this, and that the volume of the world's transactions grows very rapidly. Granting that it were true of every country what is not yet true of any which uses metallic currency at all, that it neither needed nor used metals as a circulating medium more than the United States now does—if gold is to become the sole standard there must still be in every country enough gold to inspire confidence that it can be had on demand, in addition to the supply needed for settling international balances. It may be that there is and will be enough for this use, in addition to the decreasing but considerable demand for gold as currency, without any appreciation of gold whatever; but it is certainly a doubtful experiment, and a misfortune to the world if it has to try it.

But granting all this, what else can be done? It is at least reasonably certain that gold will appreciate very slowly in future, if it appreciates at all, and granting that it is no longer to be as stable as the double standard used to be, what other recourse is there? It looks to us as if there was really no other course possible but to accept the single gold standard and make the best of it. This seems especially true because of an important fact which our Rocky Mountain friends seem to overlook. With a standard which, if anything, appreciates, men are freely willing to put out their money because they are sure of getting back in a given number of dollars at least as much value as they put out. In a standard which, if anything, depreciates, they are loth to do so, for the contrary reason: and they will certainly not forget to collect the possible depreciation (as estimated by themselves) in the rate of interest. Hence, even a slowly depreciating standard, or one merely looked on with suspicion, though it might help a few debtors already in possession of their creditor's money and able to pay it when due, would be sure to make money chronically scarce and high, besides precipitating a frantic scramble to collect outstanding debts as soon as any change of standard was really believed to be probable.

LETTERS TO THE EDITOR.

LOADS FOR EUROPEAN AND AMERICAN RAILWAY BRIDGES.

Sir: I have noted with interest the article in Engineering News of July 27, 1893, on "European Railway Practice; Reports of the National Railway Congress," especially the clause treating of the relation between bridges and rolling stock. I note the following statement:

"Track and bridges of the main international lines should be designed for a load of two vehicles having each four axles 4 ft. center to center, with a load of 14 tons per axle," etc.

This conforms very closely in principle to the standard bridge specifications of the Norfolk & Western R. R. This matter was fully presented in the discussion of Mr. Waddell's paper before the American Society of Civil Engineers, and our form of loading, with remarks, is shown in the proceedings of that society, Vol. 26, number of February and March, 1892, page 148.

I call your attention to this, as it seems to be a live question just at present. Yours truly,

Chas. S. Churchill,
Engineer of Maint. of Way, N. & W. R. R.
Roanoke, Va., July 29, 1893.

THE IDEAL ENGINEERING SCHOOL.

Sir: I have read your series of articles on "The Ideal Engineering School" with a good deal of interest and pleasure. It is needless to say that you are taking the matter up from the right standpoint. My own experience and that of all other graduates will adorn your moral. The particular point that I want to bring out is this: There is a certain element in the average student that prevents his taking the word of the professor as to the desirability of his learning certain things. Take, for instance, the matter of lettering, of which you speak. You cannot make the average student see the advantage of being a good letterer. It is my privilege to speak from experience. After I had been out of college some two years the chance was presented to go back to my alma mater as an instructor. At that time I had reached a realizing sense of the large amount of study that I needed to do before I could hope to do anything in the specialty that I had adopted, and so I accepted. The subject of "Round Writing" fell to my lot to teach. There is no quicker or neater way of making a drawing look presentable than by the use of "Round Writing." Do you suppose that I could make that class of about 15 men see the importance of faithful and conscientious work? No. They thought it was a "snap," and treated it so, despite my best endeavors.

Then, again, there are so many little wrinkles that a man has to learn from the office boy or the axeman. As you say, these might just as well be taught in the college. When I left college I served my apprenticeship to the office boy and axeman and felt a little sore, as a recent graduate is apt to feel. So when I went back as instructor I thought it would be a great scheme to teach all these little wrinkles in the drafting-room. But I met with very little success. The things were done in a perfunctory way, and I got the reputation of dealing with "the little things of life." So I came to the conclusion that the average student must learn, from actual experience, those things which seem so small and yet make life so much easier for the man who knows them.

It seems to me, from reading your articles, that you are not familiar with what is known as "lake work," at Cornell. If you will write Professor Fuertes or Professor Crandall, they will give you the scheme of this work, and you will find that it meets all the requirements that you lay down for summer work, except that it only lasts three weeks. The work done is actual work. The chief engineer is a senior. The professors are present in an advisory capacity.

In closing, I can only thank you for the series of articles, and echo your wish that the "Ideal School" may soon appear. Yours truly, M.

Cleveland, O., July 14, 1893.

(The difficulties mentioned by our correspondent in respect to interesting the students in work meant for them only shows how wholly the fact is lost sight of in our civil schools, that discipline of this character, especially in the virtues of obedience and subordination, is one of the greatest needs of the engineering student, and perhaps, the first essential for his future success. Lack of knowledge he can make up at any time if he has only been taught how to think and work for himself. An ill-trained character he can only in part correct by any efforts after he is well started in the twenties, and that part, as a rule, only by repeated sharp lessons of disappointment and failure.

We are pleased to learn that so good a beginning has already been made at Cornell in the direction we have indicated. It is only a beginning, however, unless the general scheme of organization runs through all the work of the course not strictly studious, not only in the field, but in the drafting-room, apart from the fact that the work only lasts three weeks, and is each year confined to "lake work," though we admit that that broad term may cover a great variety of training.—Ed.)

THE IDEAL ENGINEERING SCHOOL.

Sir: I have read with pleasure the discussion in your journal on the "Ideal Engineering School" and want to add a suggestion or two which has not been mentioned.

The graduate is usually posted as to figures, and can calculate lengths of sub-tangents, radii, etc., and has a good general idea of the work necessary to be done and how to do it. Now, he should be taught the absolute necessity of cultivating and always having on tap an inexhaustible supply of "good nature" and the faculty of getting along with the other members of the party; to take whatever comes in the way of hardship or annoyances without grumbling.

If the young engineer can gain the goodwill of the axeman, packers and cook they will do anything in the world for him, and he is at once a valuable man to his employers; but if he gains their ill will he will find life a burden and be steered into every hornet's nest, against every skunk, poisoned by ivy, and a trap set at every creek to get him wet. The chief of the party cannot control a matter of this kind, and the work is delayed just so much, and at the first opportunity the troublesome man is quietly dropped and some man with less engineering ability given his job.

The class starts out with a fine set of instruments, and if they happen to break one, there is nothing particular at stake. It is sent to the maker for repairs. The student should be taught (which he never is) how to sit down on a log and with a 15-cent screw-driver and penknife to put in a new set of cross-hairs Cross-hairs breaking ought not to delay the party more than an hour, including the adjustment of the instrument. The locality on this continent is rare at any season where spider web cannot be found, and ear wax will stick them to the ring in a first-class manner.

Nothing short of breaking the bubble or a lens will disable a level so it cannot be used; and as to the transit, break the legs, spring the plates, lose a slow motion screw, bend the standards, and demoralize the leveling screws so they won't work, and still the experienced engineer will do good work with it.

The instrument man should be able to do all of the above things, while the chief of party, in addition to the above, should be able to administer intelligently the standard medicines and also to use skillfully the simpler surgical instruments, and to put on a tourniquet, tie up an artery, sew up a cut, and the like. Unless he can do these things he ought not to have charge of a party, where any or all of these things may be needed.

Any ass can run a transit or level after a fashion where everything goes right, but the ability comes in in being able to do it when things don't go right, and they seldom do.

The most caustic criticism I ever heard was made by one of the locating engineers on the Canadian Pacific, anent the man who was supposed to keep him in supplies, by saying: "He ought to be appointed supply agent for a Sunday school picnic where railway communication was dead certain every ten minutes," but he did not disband the party because he was not supplied. The ability to overcome obstacles under all circumstances good naturedly is one of the most important attributes of engineering ability, and when the young engineer is equipped by his chief with the worst old rattle-traps of instruments in the office, he has been paid the highest compliment to his ability that is in his superior's power. E. T. Abbott,

Chf. Engr. Hayward So. R. R.
Minneapolis, Minn., July 23, 1893.

(Our correspondent is not quite just in saying that putting in cross-hairs is not taught at our engineering schools. It may not be at some of them, but it is now taught at most of them, that being one of the mechanical things which can be taught directly, like the process of reading a vernier. What they do not teach, and what they now make little or no effort ot teach, is the art of managing work to the best advantage, and managing men;

the art of working with other men, either as superior or subordinate or both at once, as most engineers have to be all their life long. This knowledge is to be had not from books, but most easily from early and long continued practice and drill in it, while the youth is at the impressible age and in the mood to learn. Heartaches and failures manifold would thus be saved to a large majority, and two or three years' time in getting well started to most of them. These years, moreover, are like the first day or two of a sea voyage, the most trying of all. If any one could discover a way to save the first two days instead of the last two days at sea, what a patent that would be! This benefit it is the power of our engineering schools to confer upon their students by remodeling their methods substantially on the lines we have outlined, as we believe, and as all practicing engineers who have so far expressed an opinion have in effect agreed.—Ed.)

CENTRAL RAIL TRACTION DEVICES FOR RAILWAYS.

Sir: In your issue of Sept. 8, 1892, you described a device invented by Mr. H. L. Van Zile, C. E., of Albany, N. Y., by which the resistance of a train, whether that of inertia and friction alone, as on a level, or with the addition of gravity, as on an upgrade, was made to increase the "adhesion" of the locomotive, and thus raise the limit of its traction force

This was accomplished by means of a pair of wheels, horizontal or nearly so, gripping between them a smooth central rail and carried at the ends of short levers, "the other ends of which are pivoted to the car body." It appears from the diagrams of forces in Fig. 1 of that article that the resistance of the train is applied at the free ends of these levers, or at the axles of the two grip wheels, and thus causes them to exert (against each other) a gripping force upon the center rail directly proportional to the resistance itself.

This device immediately suggested to me one proposed by Mr. George Escol Sellers, now of Chattanooga, Tenn., in 1849, and described by him in a pamphlet of that date, of which I send you a copy. I at once wrote to Mr. Sellers and he promptly replied, but pressure of other matters has prevented me from communicating with you until now. You will notice that Mr. Sellers' designs (for there are two of them) resemble Mr. Van Zile's in having a pair of wheels attached to levers and gripping between them a smooth central rail, but that they differ from Mr. Van Zile's in this very important respect, that the tractional resistance of the train is transmitted to the levers not directly, as in Mr. Van Zile's device, but by means of two togg'e joints, one of which is used when the engine is pulling and the other when the engine is pushing a train, thus overcoming the difficulty of climbing grades in both directions, to which you refer.

In both of Mr. Sellers' plans, the gripping wheels are driven by a pair of cylinders separate from those which operate the ordinary driving wheels. In the plan which he first describes, these cylinders are placed one on each side of the boiler, immediately over the driving wheel cylinders, and work, by means of very long connecting rods, upon cranks at the two ends of the transverse shaft DD, Fig. 1, whence the motion was transmitted through beveled gearing EE to the gripping wheels BB.

In the other design, the two gripping wheel cylinders were placed close together under the boiler, and between the driving wheel cylinders, and worked directly upon the vertical axles of the gripping wheels, which in this design were brought farther forward, as shown by Fig. 2. As shown in Fig. 3 (in which the levers L, L and the toggles I, I^1 are omitted), a special short horizontal shaft SS was provided in this design in order to insure that the cranks of the two gripping wheels should always be at right angles.

Mr. Sellers' proposed safety brake, like the gripping wheels, utilized the tractional resistance of the train for its operation.

Vignoles and Ericsson patented Sept. 7, 1830 (British patent No. 5,995) a central rail engine with two horizontal wheels, one larger than the other, gripping a smooth central rail, the larger wheel being worked by bevel gearing from the axle of the ordinary driving wheels, which were capable of being thrown in and out of gear. The smaller wheel was pressed against the central rail by means of a lever worked by the engineer from the footboard. Henry Pinkus patented Oct. 15, 1840 (British patent No. 8,663), a central rail device with two horizontal wheels of equal size, each carried at the end of the short arm of a bent lever. These levers cross each other like the legs of a pair of shears, the pivot being in the vertical plane of the central rail. Their long ends were connected by means of a screw with right and left hand threads, which could be tightened up by a ratchet wheel and lever, thus drawing the ends of the long arms of the levers closer together, and increasing the pressure of the horizontal wheels upon the central rail.

J. B. Fell, Engineer of the Mont Cenis road, patented in 1863 an arrangement with two pairs of horizontal wheels, in which the pressure on the central rail was secured by "the use of wedges actuated by screws." Mr. Sellers' device was patented in England, July 13, 1847, under the name of Alfred V. Newton, and, of those named, his is the only one in which the pressure on the central rail was made to vary directly with the tractional resistance of the train. In all the others, it was controlled directly by the engineer.

In 1850, the Panama R. R. requested my father, then engineer of the road, and the late Horatio Allen, its Consulting Engineer, to watch some experiments with a large working model of Mr. Sellers' engine, made by himself, and to report the result. Their report was unqualifiedly favorable, and the engines were accordingly ordered, although my father had already expressed the conviction that this precaution was not needed on the road. His successor, Colonel Totten, employed these engines only as common locomotives. In 1854, my father, as engineer of the New York & Middle Coal Field R. R., recommended the use of the Sellers engine on a grade of 150 ft. per mile, and two such engines were accordingly ordered. Financial troubles, however, led to an abandonment of the road, and the engines were sold to other companies, whose officers had the central rail machine removed and used as scrap. John C. Trautwine, Jr.

(The pamphlet referred to by Mr. Trautwine is entitled "Improvements in Locomotive Engines and Railways," by George Escol Sellers, Mechanical Engineer. It was printed at the "Gazette" office, Cincinnati, in 1849, and has some most interesting lithographic plates, from which we have prepared the figures illustrating Mr. Trautwine's letter. The Fell center-rail system was used on the old Mont Cenis Railway, which crossed the mountains before the Mont Cenis tunnel was built. The same system was used, and, we believe, is still used, on the Cantagallo Railway, of Brazil, and on a steep grade line in New Zealand. In the latter case the center rail was a double-head rail laid on its side upon a longitudinal bearing.—Ed.)

RAW SILK MACHINE WIPERS.

A novelty which has already secured an extended market for itself is a raw silk machine wiper made and sold by the American Silk Mfg. Co., of 311 Walnut St., Philadelphia. This wiper is intended as a substitute for the cotton waste, rags, hemp flitter, etc., now used, and has the following advantages over these materials: Unlike cotton-waste the raw silk is not spontaneously combustible when saturated with oil and stored in a heated place. The silk absorbs easily, is superior in softness to any of the other substances named, and it saves repairs by leaving no fiber in any part of the machinery; and for polishing machinery it is said to have no equal. By washing the wipers can be used eight to twelve times, and this washing is easily done. A saving of 50% in waste used is claimed.

These wipers are supplied hemmed and unhemmed in pieces ranging in size from 13×15 ins. to 18×36 ins., and for a bale of 1,440 pieces, or 10 gross, the prices range from $75 to $300 for the unhemmed, to $85 to $320 for the hemmed. In the unhemmed state the bale is a roll of one piece to be cut in lengths to suit.

Tests of guncotton and emmensite, loaded in ordinary steel shells and fired from a 12-in. mortar, were lately concluded at the Sandy Hook proving ground. The gun-cotton was compressed, wet, into small, rectangular blocks and covered with water proof paper, and in this form 54 lbs. of it were originally stored in five 12.2-in. shells and melted wax poured about the blocks to fill the interstices. Into each of five similar shells 87 lbs. of emmensite were packed. The object of the test was not to explode the shells but to prove that they could be fired without exploding from the shock of firing or by the heat developed. All of these shells were loaded last fall, and two shells were then successfully fired. About a month later two more were fired and the rest were then left out of doors all winter to freeze. This spring two of them were thawed out and then fired, and the four remaining shells were left exposed to sun and rain, and the last were fired a few days ago. In every case the shots were perfectly successful, as far as the purposes of the test were intended. These high explosives were fired from the mortar without explosion by initial shock or heat after having been exposed to severer trials than are likely to be met with in practice.

PROPOSED CODE OF ENGINEERING ETHICS.

The following circular was presented at the business meeting of the American Society of Civil Engineers, Aug. 2, as noted in another column. The motion to appoint the committee referred to was lost by a vote of 54 to 11:

At the annual meeting, Jan. 18, 1893, the following resolution was presented:

"Resolved, That a special committee be appointed to collect information and to consider the propriety of the adoption by the Society of a code of ethics for the profession, and to make such other recommendation as the committee thinks proper."

This resolution was declared to be subject to the provisions of Section 13, Article VI., of the constitution, and was, under those provisions, referred to the Board of Direction. The duty of the Board in such a case is declared by the constitution as follows:

"The Board shall consider the resolution and report its recommendations to the Society at the next general business meeting, together with a statement of the arguments for and against the appointment of such committee."

The Board of Direction herewith presents a statement of the arguments for and against the appointment of such committee to the business meeting of the annual convention:

Arguments for the Adoption of the Proposed Resolution.—1. The resolution is for the appointment of a special committee of this society, to collect information and to consider the propriety of the adoption of a code of ethics, and to make such other recommendation as the committee thinks proper. This does not commit the society to the adoption of a code of ethics, but simply proposes the appointment of a committee on this general subject. There should be no objection to the appointment of a carefully selected committee to consider the subject, and the members of the society will certainly have larger information and be in a better position to determine as to the propriety or impropriety of the adoption of a code of ethics after the report of such a committee than without such report, the subject never having been carefully considered or presented as a society matter.

2. The difference of opinion on this general subject which evidently exists among engineers is a good reason for the appointment of the proposed committee, so that the subject may be presented for further consideration and discussion in a clear and definite shape.

3. There seems to be some question as to whether civil engineering may properly be called a profession. A clear statement of what the word means is given by the "Century Dictionary," which defines a profession to be:

"The calling or occupation which one professes to understand and to follow; vocation; specifically a vocation in which a professed knowledge of some department of science or learning is used by its practical application to affairs of others, either in advising, guiding or teaching them, or in serving their interest or welfare in the practice of an art founded on it." The same authority adds: "Formerly, theology, law and medicine were specifically known as the professions; but as the applications of science and learning are extended to other departments of affairs, other vocations also receive the name. The word implies professed attainments in special knowledge, as distinguished from mere skill; a practical dealing with affairs as distinguished from mere study or investigation; and an application of such knowledge to uses for others, as a vocation, as distinguished from its pursuit for one's own purposes. In professions strictly so called a preliminary examination as to qualifications is usually demanded by law or usage and a license or other official authority founded thereon required."

This definition seems very clearly to apply to the actual facts of the practice of civil engineering. Men who have any right to be called civil engineers, and who have any right to be corporate members of this society, do have a vocation in which professed knowledge of some department of science or learning is used in practical application to the affairs of others. If the proposed committee finds it desirable it would doubtless recommend some means of carrying out or of enforcing regulations for such of the relations of engineers to their clients and to each other as could at all be made subject to rules. At all events, it is desirable that the committee should study this subject and report to the society.

4. Rules do exist which govern the relations to each other and to the public, of men following other professions or vocations in which there are associations of the members of such profession or vocation in some respect similar to this society. This applies, not only to the old so-called professions, but to other vocations. The dealers in stocks are subject to clear and definite rules, formulated and enforced through their exchanges. The dealers in produce are also subject to rules through their exchanges, and this is the case in other vocations.

5. It will be well to appoint a committee to consider whether the dignity of civil engineering and the relations of members to themselves and to the public might not be improved by the application of rules of ethics or of conduct to be adopted by this society as a representative body.

6. It seems to be a fact that civil engineers do permit themselves in some few instances to act in ways which in other professions or vocations would be generally considered improper and unprofessional acts. Such acts are contrary to the rules of etiquette which have become standard in those professions. The appointment of a committee to see whether this can in any way be remedied as regards civil engineers is desirable.

7. The lack of rules by which departures from the proper line, and professional line of conduct can be judged affords excuses for unprofessional conduct when such conduct is based upon ignorance of, or indifference to, professional morals. The adoption of rules and principles governing the relations of engineers to each other and to their clients would restrain the unprincipled and guide the ignorant.

8. The fact that many engineers are engaged in salaried positions should be an argument in favor of, rather than against, the appointment of a committee to consider the possibility of a code which would add to the dgnity of the profession. Those who require the services of engineers are apt to base their appreciation and estimate the value of those services upon the standing which the engineer himself takes. It is inconsistent with the function of this society to depreciate engineering. It is its duty to endeavor to elevate it in every relation, and the appointment of the proposed committee will be a step in this direction.

Arguments Against.—It is held that one may just as well assert that the other great professions are great in spite of their codes as because of them. Neither assertion can be proved. It seems to be a fact, however, that the lawyers have no formal code. Their rules of conduct are partly matters of tradition and partly of interpretation and construction, by various authoritative bodies, and form a valuable mass of professional ethics, but they have not been codified and adopted by the great bar associations in the United States.

Furthermore, one of the most important medical societes of the United States, the Medical Society of the State of New York, has voted to abandon its code of ethics. The fundamental reason for this action is summed up in these words of the president of that society:

> It would comport more with the dignity of the medical profession, and would enhance the respect in which it is held by the general public, if all specific rules of ethical conduct were elided from the by-laws of the State Medical Society and if the regulation of such matters were hereafter left to the judgment of individual practitioners influenced by the well known consensus of professional opinion and by local custom.

It is believed that the architects also are without a formulated and accepted code of ethics. So we see that the professions are either without codes or are beginning to abandon them. The rules governing the transactions of the stock and produce exchanges are not analogous to what is understood by a code of professional ethics; they provide simply for the carrying out of specific contracts, many of which are not enforceable by law, but the carrying out of which is vital to the existence of the business of the exchanges.

It is held that it is impossible to frame a code of ethics that would cover all cases. Such a code would be too complicated and minute to be successfully administered. The code, therefore, must be merely a statement of general principles; but such statements have been made by moral teachers ever since society began, and the general principles which govern human conduct are sufficiently well formulated already.

A strict code would restrain those who need no restraint, but it would not be regarded by the unprincipled further than their own interests dictated. It would happen sometimes, perhaps often, that an engineer would be deterred from doing his duty to his client or to himself by a timid obedience to the code, or that he would make the code an excuse for not doing disagreeable things which reflected upon the honor or the capacity of other engineers.

It is held that specific cases of violation of the traditions and spirit of the profession should be treated individually, each on its merits, and that this can be done, so far as the American Society of Civil Engineers is concerned, by presenting the case to the Board of Direction, or that a special body or committee can be created in the society to perform this special function.

The Board of Direction recommends to the society that no such committee be appointed.

The assessment of Kansas railways for taxation has been completed by the Populist state officials, it is stated, and reaches $67,000,000, or $15,000,000 more than the assessed valuation for 1892. This will increase the taxes of the Atchison, Topeka & Santa Fe R. R. about $200,000, and those of the other roads in proportion. By the same assessment the valuation of other property has decreased, while railway property has increased 30%. It is probable that the railway companies will contest the legality of the assessment.

COMPARATIVE VALUES OF TIMBER.

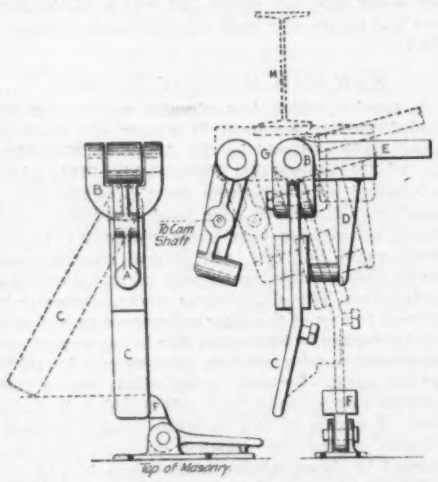
In a lecture on timbers used for railway purposes, delivered by Mr. Goff, at the Railway Institute, Sydney, New South Wales, it was stated that timber when perfectly dry lost about one-third of its weight, and the following timbers shrink in breadth in drying as follows: English oak, $\frac{1}{12}$; Riga fir, $\frac{1}{32}$; Dantzic, $\frac{1}{28}$; elm, $\frac{1}{24}$; yellow pine, $\frac{1}{18}$; pitch pine, $\frac{1}{10}$, and kauri, $\frac{1}{24}$; In his comparison Mr. Goff took English oak as a standard of measure of the qualities of strength, stiffness and toughness, and explained that by strength he meant the property which resists fracture or breakage whether as a beam or post; stiffness, the quality of resistance to flexure or bending; and toughness, the power to bend the most before fracture. The following table of comparative qualities of various woods was presented:

Variety.	Weight per cu ft.	Strength.	Stiff-ness.	Tough-ness.
British oak	45 to 58 lbs	100	100	100
BalticRiga oak	43 to 54 lbs.	108	93	125
American oak	37 to 47 lbs.	86	114	117
Dantzic oak	42 to 53 lbs.	107	117	99
Elm	35 to 46 lbs.	82	78	86
Pine or fir	29 to 42 lbs.	80	114	58
Poplar	33 lbs.	86	66	112
Mahogany	35 to 53 lbs.	93	93	99
Tamarac	32 to 40 lbs.	102	80	130
Walnut	50 lbs.	93	70	110

AN AUTOMATIC END LATCH FOR SWING BRIDGES.

We illustrate in the accompanying cut an ingenious automatic end latch for swing bridges, designed by Mr. Charles E. Fowler, Jun. M. Am. Soc. C. E., Chief Engineer, Youngstown Bridge Co., Youngstown, O. In designing a 200-ft. swing span it became advisable to do away with a separate lever to operate the end latch, and this automatic latch was designed to overcome the difficulty. The operation of the latch is clearly shown in the drawing, for which we are indebted to Mr. Fowler.

The latch box G, which carries the levers, A, B, C and D, is attached to the end floor beam H.



An Automatic End Latch For Swing Bridges.

The latch bar E of required size is of wrought iron and is fastened to the lever D by bolts. The shaft which works the cams is located about the middle of the end panel and carries at the center of the roadway a lever connected by a rod to the lever A. When the cams, or wedges, are drawn back, this lever, being on the opposite side of the shaft, throws the lever A forward. Lever A strikes the lever C and this in turn strikes the lever D, thus raising the latch. The position of the levers at this moment is shown by the dotted lines.

Attached to the masonry is the tripping lever F, and when the bridge is opened a few feet so that the latch bar E is free from the socket, the lever C strikes on F and is drawn to one side, as shown by the dotted lines. This allows D to drop back and E to resume a horizontal position ready to relatch when the bridge is closed. When the bridge is being closed, if the bar C has not returned to its vertical position, it will strike the opposite side of F and simply revolve it, doing no damage. When the bridge latches the raising, or throwing forward, of the cams draws A back and allows C to return to its first position ready for business again.

COUNTRY ROADS AND ROADMAKING.

There is an abundance of hard, common sense and good advice in an address on this subject delivered by Mr. F. Hodgman to the members of the Michigan Engineering Society. We give the greater portion of it in the terse words of the speaker, as follows:

To make good roads first get the best location.—That text warrants a long sermon. For main roads between important points use the shortest line which is consistent with the easiest grades and lightest work in building. Locate the line upon the same principles that a railroad is located. We seldom do it. We locate roads on section or farm lines when it would be cheaper to buy a man's farm outright and get a good location, rather than to locate and build it on the boundary line. We are generous. We climb hills and dig them down year after year, at no end of trouble and expense to the public, just to keep some man's fields square so that his corn rows will come out even. We are going to keep right on doing so.

Clear the roadbed of trees, brush, stumps and stones, if there are any. Cut down hummocks and fill holes. Subsequent treatment will vary as the soil varies. As soon as things are ripe for it, begin grading. Do it systematically. Adopt a permanent grade and work to it, so that work once done will stay done. Finish as you go. Do not begin grading a foot more road than you can finish while you are at it. This does not apply to the big hills and hollows that must be dug down and filled up to all eternity.

Drain clay soils thoroughly.—Water must be speedily got rid of if you would have a good road. Read that over till you have it by heart. Do not be afraid to go outside the road. Ask the owner to help you open the watercourse across his land till the water has a free outlet from the road. If necessary call on the drain commissioner. A few dollars spent in this way will sometimes do more good than ten times the amount spent on the road itself. Tile drains are a great help to some roads. Lay them lengthwise of the track on each side of it. They do little good under the track because the surface becomes puddled so the water does not reach them readily. Be sure the tiles are laid to a true grade and have a free outlet. Wherever there is a sag in the tile the sediment will settle. If the sag is as great as the bore of the tile it will sooner or later cause an entire stoppage. Lay the tiles from 2 to 4 ft. deep, according to circumstances. Clay roads must be turnpiked or raised in the center, to carry off the surface water. Plow a back-furrow down the center of the road and keep plowing in until it has the desired slope. Keep the ground finely harrowed so as to have the soil perfectly homogeneous and uniform. Do not raise it too high in the middle. A rise of 1 in 20 is enough.

In Chicago they used to raise the center of the streets 18 ins. They now raise them only 8 ins., and get better results. When a wagon is on the slope of a turnpike it is tilted to one side. The most of the weight is on the lower wheels, increasing their tendency to cut a rut, which will intercept and hold more or less of the surface water. That softens the ground and the wheels cut deeper. So it goes on from bad to worse until the limit is reached. The steeper the slope the worse it is, defeating the very object it was made for. The strain on the wagon is greatly increased, and by taking the lower wheels and axles at a disadvantage greatly increases the danger of breakage.

Do not use a scoop scraper in finishing a roadbed. It is a nuisance. It leaves its loads in hard bunches with soft spaces between, some of which will surely develop into mudholes. Flat scrapers with tongues are much better. You can distribute the dirt evenly with them. A road machine is a good tool to finish the surface with, if you know how to use it, or to spoil it, if you don't. When you have the road thoroughly worked, and just where it ought to be, roll it down hard. Farm rollers are not heavy enough to do the best work. Rollers are made on purpose for it, and ought to be used more than they are. Bring the roadbed to the grade where it is to stay the first time you plow it, and then be sure that the plow is never put into it again. A man who will plow up a graded and well settled roadbed ought to be prosecuted and fined to the full extent of the damage he does, including damages done to people's feelings who have to travel over such a road.

If the soil is muck, put an open ditch on each side of the road at least 20 ft. from the center, and give it free outlet. If you have good reason to suspect the presence of a sink hole, do not cut the surface at all, as it will do more hurt than good, in case there is one. If the muck is very soft you may have to put in a log crossway for a foundation. Put good, solid stringers lengthwise of the roadbed. Notch the crosslogs onto the stringers so they will stay firmly in place, and be as even on top as possible. If they are flattened on top, so much the better; they will need but little covering. If not flattened, put on a good layer of brush and marsh hay, and cover it with the best dirt you can

get. A log crossway becomes in time a great nuisance, unless the logs are below frost. The frost lifts them and keeps the road filled with bumping places.

Except in the softest ground brush makes a better foundation than round logs, and will last until the ground is settled, so it is no longer needed. Use plenty of it. Pack it as closely as possible, and give it a good covering of gravel with a little clay in it if you can get it.

Do not turnpike a sandy road nor drain it. Wet sand makes a better road than dry sand. I am not speaking of quicksand. Sandy roads are usually pretty level, and need little, if any, grading. They should, where it is necessary, be leveled off as evenly as may be. Encourage grass to occupy all the space it can. It pays well to give some sandy roads a heavy coat of manure for the benefit of the grass. Don't turnpike a sandy road. It is a damage to it. Put a coat of 6 ins. or more of stiff clay on a sandy track, and it makes a pretty good road of it. Straw, marsh hay, waste from sorghum mills and the like make good temporary applications for sandy roads. They improve the roads greatly while they last, and it pays well to use them in bad places when you cannot do better.

The time soon comes in the life of a road, if it is much used, when it will pay to give it a better surface than can be had from sand, muck or clay. Where gravel can be had it is the first thing to use. It makes a surface hard enough for almost any country road, and is a good foundation for a pavement. When you gravel a road begin at the part nearest the gravel, and put on an even layer about 4 ins. thick, driving over it as the teams come and go. When one such coat is on, wait awhile until it is solidly packed by the passing travel. Then put on more in the same way, until you have enough on. The object in applying it in this way is to have all the gravel solidly packed from top to bottom. It makes a big difference whether this is done or whether you have a hard crust on top with loose gravel beneath. If you have a good road roller you can pack the gravel with that without waiting for the teams to pack it. The foundation, too, should be rolled as hard as possible. Don't use sand instead of gravel. It is a waste of time and money. The gravel should consist of grains from the size of a kernel of wheat to a hickory nut. Sharp, angular grains are best. If the gravel is to be put on sand a little stiff, tenacious clay mixed with it is an improvement. On clay it will get all the clay it needs from the roadbed. When your roadbed is well graveled, let it alone, except to patch up any holes as soon as they show themselves.

Don't Plow It Up.—Nothing better than gravel will be needed for a majority of country roads. When the traffic will warrant paving, it will generally warrant a rail road, which is pretty sure to come. If the road must be paved, call on an expert for advice. It is the best and cheapest way.

I will close with a very few words on repairing dirt roads. A road machine is the most effective tool I know of for this use. It wants a man to run it who knows his business. Such men are scarcer than the machines are. The machine should be run over the ground in the spring as soon as the ground is well settled, and afterward during warm weather as often as the roads become rutted. It will smooth down the rough places, fill the ruts and leave the road in the best possible shape. If not properly used the road machine is a nuisance. I believe that a great deal more harm than good has been done with them. Too steep slopes are made with them, and big ridges of loose dirt are left in the center, compelling teams to follow the slopes. No ridge of loose dirt should be left. It should be evenly spread over the surface with the machine, and then rolled down hard.

RECENT PRACTICE IN PUMPING ENGINES.*

By F. W. Dean, Mem. Am. Soc. M. E.

The development of pumping engines is a subject of great fascination. It seems strange to us that the Cornish engine should have reached such a state of perfection before the middle of this century as to give a duty of 120,000,000 ft.-lbs. per 100 lbs. of coal, but there seems to be no doubt that this was accomplished in 1840 at Fowey Consols mines in Cornwall by an engine with a cylinder 80 × 124 ins. and carrying a net pressure of 12.57 lbs. of steam per sq. in. This high rate of duty was brought about by using the steam expansively, by using steam jackets well protected, by an ingenious arrangement of valves which prevented the condenser temperature from extending to the steam side of the piston, adjacent cylinder heads and clearances, by compressing the steam to the initial pressure by wire drawing and somewhat superheating the working steam and causing the initial pressure and temperature to be considerably below those in the jacket, and thus almost wholly preventing condensation. The efficiency of the jacket was increased by the slowness of the return stroke of the steam piston and by a pause of nearly a quarter of a minute between the completion of this stroke and the beginning of the steam stroke. The steam stroke was made with astonishing rapidity for such ponderous moving parts, amounting in cases to a rate of 500 ft. a minute, and thus minimizing condensation. The most economical performances of these engines occurred when they were new and underworked. When the mines grew deeper and the steam worked less expansively the duty diminished. The engine that once gave 120,000,000 duty, two years afterwards gave 77,000,000.

*A paper read before the New England Water-Works Association at its annual meeting at Worcester, in June, 1893. The paper, with discussion, will appear in the journal of the association.

The principle of expansion and the importance of diminishing condensation in steam cylinders were well understood in those days, the former having been thought out in 1769 and the steam jacket invented in 1763, both by James Watt.

The average annual duty of Cornish engines in 1840 was about 55,000,000 ft.-lbs. (See "Performance of the Best Modern Pumping Engines, Compared to that of the Cornish Pumping Engines, in the Period of 1840," by Prof. J. E. Denton, Eng. News, Dec. 28, 1889.—Ed). Previous to 1873 the usual duty of pumping engines in this country was about 60,000,000 ft-lbs. per 100 lbs. of coal, but in July, 1873, this time-honored record was broken by the so-called Morris engine at Lowell, Mass. This is a 5,000,000-gallon compound vertical engine of the Simpson type, having both cylinders under one end of the beam and the pump and flywheel under the other. Steam enters the high-pressure cylinder from the boiler, and at the completion of the stroke flows into the opposite end of the low-pressure cylinder, the steam flowing from one to the other during the whole stroke.

In July, 1873, a board consisting of Messrs. Hoadley, Francis and Worthen obtained a duty from this engine of 93,002,272 ft.-lbs. per 100 lbs. of coal.

About this time the Worthington horizontal compound duplex engine was being introduced with great satisfaction, and gave a duty of about 60,000,000 ft.-lbs. The first engine of this type was built for the Charlestown, Mass., Water-Works, and was erected in 1864. A duplicate was there erected in 1896. The cylinders were 25 and 43 ins. by 48-in. stroke. The pump plungers were 22 ins. and the delivery pipe 30 ins. in diameter. The engines have been in service ever since, and are at work at present. This is a remarkable record, extending nearly 30 years.

A distinct impulse was given to high-class pumping machinery by Mr. E. D. Leavitt, whose engine at Lynn was tested in December, 1873. This was an improvement on the Morris engine at Lowell in consequence of the pistons moving in opposite directions, and thus diminishing the length and volume of the passages between the cylinders. These features were accomplished by connecting the pistons to opposite ends of the beam and thus permitting the high-pressure exhaust to pass to the nearest end of the low-pressure cylinder. The virtues of this arrangement were still farther brought out by inclining the cylinders so as to bring them as near together as possible.

The superiority of the Lynn over the Lowell engine did not end here. This engine had a type of steam valve that gave a large port opening with small clearance between the piston at the end of the stroke and the valve face, and thus diminished losses to which the Lowell engine was subject. Moreover, the Lynn valves do not, like those at Lowell, leak with age.

The whole effect of the Lynn design was to diminish condensation, loss of work between the cylinders and loss of steam in the clearances of the low-pressure cylinder by discharging it to the condenser. This engine was tested by Messrs. Worthen, Hoadley, Kirkwood, Hermany and Davis, and gave a duty of 103,923,215 ft.-lbs., being the highest duty ever recorded in the United States up to that time. With it began an era of high duties in this country which have ever been increasing until it seems that there is but little more to be accomplished. I shall dwell a little upon the Leavitt engines, because in them now are to be found all those features that promote economy in steam engines, and their development is interesting.

The Lynn engine was followed by those at Lawrence (Eng. News, Sept. 5, 1878), which are of the same type, but larger. They were carried out better in detail at the steam end, but chiefly on account of great pump friction the duty was lower, being only 96,186,979 ft.-lbs. The official test was made by Messrs. Worthen, Hoadley and Davis on May 2-6, 1876. Mr. R. H. Buel tested these engines in July, 1879, after some changes had been made in the pumps, and obtained a duty of 111,548,925 ft.-lbs. A portion of the improvement was caused by better boiler performance.

Mr. Leavitt did not repeat this design, having seen the advantages of inverting the engine. He then placed the cylinders upon the tops of columns, the beam in pedestals in the bedplate beneath and the main shaft in pedestals at one end of the bedplate. Two pumps instead of one, and a great many small pump valves instead of a few large ones, were used. The cylinders were placed as near together as possible, but for simplicity only the high-pressure cylinder was inclined. By this design the economy of steam obtained at Lynn and Lawrence was realized, greater stability was obtained, shorter steam and pump connections were practicable, and two pumps could be used with great convenience. Moreover, most of the parts were more accessible than in the Lynn type.

The inverted type just described is best illustrated by the pumping engine "Ontario," at the Calumet & Hecla mine. It has a vertical low-pressure cylinder 36 ins. in diameter and an inclined high-pressure cylinder, 17½ ins. in diameter, the stroke of both being 5 ft. The maximum speed per minute gives a plunger speed of 330 ft. per minute. This engine runs 24 hours a day six days in the week, and is one of the smoothest and best working pumping engines in the country. It has been speeded up several times in order to keep up with the demand for water, and thus far runs better with the higher speed. It has 72 suction and the same number of discharge valves, both 5¼ ins. in diameter and 3 ins. maximum lift. The pumps have differential plungers, each single-acting on the suction and double on the discharge.

The next Leavitt engines bearing new features are the Boston sewerage engines (Eng. News, May 8, 1880). While they resemble the Ontario, both cylinders are vertical, Mr. Leavitt having by that time seen that by placing a cut-off valve on the low-pressure cylinder there was no longer need of keeping the cylinders near together. By a proper determination of the point of cut-off in this cylinder most of the loss of work between the cylinders caused by unresisted expansion or drop is done away with. Here is seen for the first time a reheating receiver between the cylinders for the purpose of drying the steam exhausted from the high-pressure cylinder. The reheating is done by steam of boiler pressure within many small brass tubes, around the outside of which the exhaust steam plays.

The cylinders of this engine are too large, the engine having been designed for a greater lift than that finally adopted, but notwithstanding the great expansion of the steam and the slow speed, the engines use but 14 lbs. of steam per I. HP. per hour. The number of expansions with 96 lbs. of steam at the engine was 22, and the number of revolutions per minute about 13½, corresponding to 240 ft. of piston speed per minute. Now this economy, notwithstanding unfavorable conditions, is without doubt due to steam jackets and the reheater.

The next Leavitt pumping engine that deserves attention is the 16,000,000-gallon engine designed for the Louisville Water Co., of Louisville, Ky. This engine has steam cylinders 27 and 54 ins. by 10 ft. stroke, and is to run 18 revolutions per minute, giving a steam piston speed of 360 ft. per minute. The engine, like the Ontario and sewerage engines, is inverted, with the beam under the cylinders, but, unlike the sewerage and like the Ontario, has the flywheel out at the end of the bedplate. The plungers are two in number, of differential type, and are connected to the beam at points between the ends and center of the beam, so as to give a stroke of 7½ ft. to the plungers. This gives a plunger speed of 270 ft. per minute. This engine is to work with 140 lbs. of steam by the gage, and ought, if the jackets and reheaters are as efficient as anticipated, to use somewhat less than 14 lbs. of steam per horse-power per hour.

This engine is remarkable in having very long pump chambers on account of its location. The Ohio River water level at Louisville varies some 50 ft., so that the engine proper is placed high and the pump reaches to the low water level. Each pump is 61 ft. long, 8 ft. inside diameter, and each plunger is 40 ft. long. There will be 143 suction valves and 124 delivery valves to each pump. This engine is not only remarkable for the height of the pumps, but also for the weight of all the parts, it being the determination of the water company to prevent breakage if possible. The total weight of the engine is 800 tons. The Louisville engine is the last Leavitt compound pumping engine built, and represents its highest development.

This was followed by a 60,000,000-gallon triple expansion engine, to carry 185 lbs. of steam, for the Calumet & Hecla mines, but of this I am not at liberty to speak.

Following this came the new engine for the Chestnut Hill pumping station for the city of Boston, which is to be of 20,000,000 gallons capacity (Eng. News, Dec. 22, 1892). This is a triple-expansion engine having cylinders 13,7 24⅝ and 39 ins., with 6-ft. stroke, and has three plungers 17½ ins. in diameter by 4 ft. stroke. The engine will make 50 revolutions per minute, corresponding to a steam piston speed of 600 ft. per minute and pump plunger speed of 480 ft. per minute. The steam pressure will be 185 lbs. by the gage, giving about 30 expansions. The steam consumption ought to be below 12 lbs. per horse-power per hour.

During the development of the Leavitt pumping engine Mr. Geo. H. Corliss was giving much thought to the matter, and built two experimental engines, which he worked in the shops at Providence. His Pawtucket

engine was started on Jan. 30, 1878, and tested in October, 1878, by Walter H. Sears and Isaac N. Scott. The duty per 100 lbs. of coal during a 24 hours' test was 133,522,000 ft.-lbs., which is the highest duty ever recorded for a compound engine. The Pawtucket is a cross-compound, having cylinders 15 and 30 by 30 ins., and runs 49 revolutions per minute. The pump plungers, two in number, double-acting, are 10.52 ins. in diameter, and have a 30-in. stroke. The steam piston and pump plunger speed is 245 ft. per minute.

This engine is remarkable in many particulars. It has beams that give a crank throw double that of the piston travel, the beams being built up partly of wrought iron links of very light and lofty construction. It has not only surpassed all records of compound engines in this country for economy, but is remarkable for having cost virtually nothing for repairs. This immunity from repairs is said to be due to the elasticity of its construction and the resulting diminution of shocks. It is also remarkable for having a great number of pump valves, 2¼ ins. in diameter, with a lift of ¼ in. The aggregate area of these valves is equal to the area of the cross-section of the plunger. They are made of bronze annular discs 1-32 in. thick, and while they slam on their seats, they are so light and move so little that they neigther injure themselves nor their seats.

This engine was tested by Prof. J. E. Denton, and gave a duty of 127,350,000 ft.-lbs. per 100 lbs. of bituminous coal, and would have given 136,000,000 ft.-lbs. if the boilers had evaporated 10 lbs. of water per pound of coal. The steam used per horse-power per hour was about 13¾ lbs. The cylinders are jacketed, but careful experiments show that the jackets have not in this case the usual value, saving only some 2 or 3% of steam. A source of economy of the engine is the location of a reheater in the smoke flue through which the condensation from the receiver is passed and then returned to the low-pressure cylinder.

In 1881, Mr. Corliss erected a pair of compound vertical beam pumping engines at the Pettaconset pumping station at Providence of 9,000,000 gallons' capacity, guaranteed to give a continuous duty of 100,000,000 ft.-lbs. The engines have one high-pressure cylinder under one beam 18 ins. in diameter and one low-pressure under the other beam, 36 ins. diameter, both strokes being 6 ft. Each engine works two 19-in. plungers with 36-in. stroke. The pumps have valves like those in the Pawtucket engine. This engine gave an average duty for one year of 106,048,000 ft.-lbs., and on a test by Samuel M. Gray, during six days of about 12 hours each, including banking coal, a duty of 113,271,000 ft.-lbs. The estimated duty of the engine, with banking coal deducted, was 138,035,000 ft.-lbs.

A second engine was put in at Pawtucket by Mr. Corliss (Eng. News, Jan. 18 and 25, 1890), being in most respects like the first engine, and this ended Mr. Corliss' work in this kind of engineering.

Among the flywheel pumping engines deserving great attention, both on account of the merit of the arrangement of the cylinders and the great number in use, is the Gaskill engine. This accomplishes in a very perfect way what was sought by the first Leavitt design, viz., opposite movements of high and low-pressure pistons and direct steam passages from one cylinder to the other. This engine ought to be unsurpassed as an economical steam user by any engine without a reheater and a cut-off on the low-pressure cylinder. The usual amount of feed water used by it per hour per horse-power is about 17 lbs., although occasionally it is less. At Philadelphia the amount reported is 14.94 lbs., practically 15 lbs.

The pump end of the Gaskill engine is distinguished by the use of numerous small rubber-faced valves, over openings 2¼ ins. in diameter, and lifting 5-16 in. The valves are exceedingly simple, and are within cages screwed into the valve plates of the pumps. The engine is slow running, and has a small aggregate area of valve opening, but there seems to be no reason why it should not run fast if ample valve and waterway area is given. The usual duty of the Gaskill engine on trials appears to be 105,000,000 ft.-lbs.

A newly introduced compound flywheel pumping engine is the Blake engine, of which six have been built. This engine has one high and one low-pressure cylinder and a Corliss valve gear controlled by a governor. The gear is so made as to give a range of cut-off from 0 to ¾ stroke. It has two cranks at right angles to each other, a cut-off on the low-pressure cylinder and a reheating receiver. It has all the usual means of economy, and, as might have been expected, uses about 14 lbs. of feedwater per horse-power per hour.

The pump end has many small valves, with a small lift and aggregate opening of over 1½ times the plunger area. The usual duty to be expected is about 120,000,000.

One of the most interesting, important and scientific improvements in pumping engines is that of elevating the direct-acting pumping engine to the position of being a high-duty engine. The writer believes that there were several almost simultaneous inventions to accomplish this end, but that with which we are familiar is the high-duty pumping engine manufactured by H. R. Worthington. The Worthington compound duplex pumping engine, until this improvement was made, was a low-duty engine, because it could expand the steam only an amount due to the cylinder ratio, because it had large clearances, and could not compress steam in them up to the initial pressure. By means of the high-duty attachment and a change in the valve gear, most of these defects are eliminated, and the great advantage is gained that the steam can be cut off at any desirable point, and any degree of expansion obtained. There are two sets of valves to each cylinder, two for admission and exhaust and two for cut-off. The admission valves of the cylinders on one side of the engine are operated by the machinery of the other side, while the cut-off valves are operated by the same side. This enables the peculiar relative motion of the two sides to be retained and still makes it easy to secure a cut-off at any point.

In any pumping engine the resistance on the plungers is nearly constant, but if the steam is cut off the propelling effort so quickly diminishes that the plungers would stop unless a flywheel or some equivalent device should carry them on. The high-duty attachment accomplishes this in virtue of having plungers which have upon them pressure from the force main augmented by a special accumulator. During the first half of the stroke of the engine these plungers are forced in by surplus steam pressure, and during the last half the accumulator pressure forces them out and completes the stroke, and thus fully compensates for the low steam pressure due to the early cut-off and resulting expansion.

The Worthington high-duty compound engine appears to use about 16¼ lbs. of steam per horse-power per hour, and therefore uses $\frac{16.25}{14} = 1.16$ times as much steam as a good flywheel engine. It would, therefore, in general give a duty of about 106,000,000 ft.-lbs.

It would be interesting to inquire why this engine is not as economical as good flywheel engines. The writer has not had time to investigate this fully, but an inspection of the cards and an examination of the engines show that there is not and cannot be a closure of the exhaust valves early enough to compress the steam in the clearances up to initial pressure, in either cylinder. If this were attempted the compensating cylinders would not have pressure enough to complete the stroke. If the stroke is not completed the clearance is increased with the attendant loss. The engine has the important features of a cut-off on the low-pressure cylinder and a reheater.

The last engine that I shall consider is that of which a specialty is made by the Edw. P. Allis Co., of Milwaukee, Wis. It is a vertical three-crank and three-pump triple expansion engine with cranks 120° apart. The pumps are of the single-acting, outside-packed plunger type, making their strokes at equal intervals of the revolution, and thus giving a steady flow of water. The steam cylinders have the Corliss type of valve gear, although I believe that in a few cases a single-beat poppet valve has been applied to the heads of the low-pressure cylinders for the purpose of reducing the clearance and thus diminishing the waste to the condenser. The engines are also provided with steam jackets and two reheaters, one between each two cylinders. There is a variable cut-off on each cylinder, that on the high-pressure being under the control of a centrifugal governor. In a general way the engine is provided with all the essential features for economy, and the performance must depend upon whether the designer has made the most of his opportunities.

Attention was called to this type and make of engine by the remarkable performance of the first one at Milwaukee, which was phenomenal in consequence of the low pressure of steam used, viz., 80 lbs. by gage, and the ordinary rate of speed of 25½ revolutions per minute. The amount of feed water used per indicated horse power per hour was 13.84 lbs., and the duty per 100 lbs. of coal was 129,403,204 ft.-lbs.

At St. Paul a similar engine gave a duty of 113,611,037 ft.-lbs. with 90 lbs. of steam when running at 30.4 revolutions per minute.

At the Harrison Street pumping station, Chicago (Eng. News, May 31, 1890), this type of engine gave a duty on an eight hours' test of 140,416,679 ft.-lbs. with 1,000 lbs. of steam, and used 12.675 lbs. of feed-water per I. HP. per hour. The steam gage pressure was 125 lbs. per sq. in., and the average speed 16⅔ revolutions per minute.

The latest test of this type of engine was made by Professor Carpenter, of Cornell University, at Milwaukee, on March 25 and 26, 1893. The engine has cylinders 28, 48 and 74 ins. in diameter, and three 32-in. single-acting plungers, all of 60-in. stroke; uses steam of 120 lbs. pressure by the gage, and makes 20½ revolutions per minute. The capacity is 18,000,000 gallons per day against a total head of 161.845 ft.

The duty per 100 lbs. of dry coal was 143,306,470 ft.-lbs.

The duty per 1,000 lbs. of feed-water was 152,448,000 ft.-lbs.

The duty per 1,000,000 British heat units was 137,656,000 ft.-lbs.

The indicated horse-power was 573.87.

The friction horse-power was 52.91.

The friction horse-power was 9.22%.

The dry steam used per indicated horse-power per hour was 11.678 lbs.

British thermal units per indicated horse-power per hour, 217.6.

The amount of steam consumed per hour per horse-power by this engine is nearly unequaled, if not quite, although it is said that Sulzer engines in Europe have used less steam, and that a Willans engine in London has used 11 lbs. of steam while being tested with every care to promote economy.

The clearances of the Allis engine last described are remarkably small, being as follows:

High-pressure cylinder.....	14 %
Intermediate cylinder....	1.5 %
Low-pressure cylinder.... ....x..	0.777 %

The piston and plunger speeds were 203⅓ ft. per minute.

I have dwelt upon this type of engine because there are comparatively few of them in use and because they show what a triple expansion engine can do. They are also interesting because they have used low steam pressures. The triple engine has the important advantage of more uniform pressures or bearings, and is therefore steady running and less likely to heat its bearings than the double expansion or simple engine.

Here I may properly refer to the importance of a governor to a pumping engine, for with it the engine will come to rest if a water main bursts. In the case of the Worthington high duty engine such a catastrophe will stop the engine by removing the pressure from the accumulator and compensating cylinders, and thus deprive them of power to complete the stroke. The engine consequently stops.

Having now considered the prominent types of pumping engines, it is important to discuss the essentials to economy and what we have to hope for in future. To assist in this I here tabulate the usual amounts of steam used per hour per horse power by the various types, all having cut-off valves on the high cylinder and all steam jacketed.

(1) Compound flywheel without cut-off on low pressure cylinder and short steam passages, 17 lbs. per I. HP. hour; relative value, 0.735.

(2) Compound duplex direct acting with cut-off on low pressure cylinder and reheater, 16¼ lbs.; relative value, 0.769.

(3) Compound flywheel with cut-off on low pressure cylinder and reheater, 14 lbs.; relative value, 0.893.

(4) Triple expansion flywheel with cut-offs and intermediate and low pressure cylinders and two reheaters, 12½ lbs.; relative value, 1.

It is well known that the greatest obstacle in the way of economizing steam is the prevention of condensation in the cylinders, and it is now well understood that this is chiefly dependent upon the range of temperature in the cylinders. While there is economy in the increased expansion that can be obtaind from the higher pressures, there is a loss from condensation from the enlarged range of temperatures. If a lower pressure is used with the same number of expansions the range of temperature is reduced. For example, in a triple expansion engine carrying 185 lbs. of steam by gage, and another carrying 125 lbs., the temperatures and ranges are as follows:

Gage pressure.	Temp. of high pres. inlet steam.	Temp. of low pres. exhaust steam.	Total range.	Range in each cylinder.
185 lbs.	382°	142°	240°	80°
125 lbs.	353°	142°	211°	70°

While there is great economy to be realized from the earlier stages of expansion there is much less from the later stages; for example, the value of a pound of steam when following a piston full stroke being 1, that for four expansions or a quarter cut-off is 2.386, and that for one-tenth cut-off is 3.303; differences, 2.386 and 0.917. By the use of 125 lbs. gage pressure there are in general 20 expansions, and by the use of 185 lbs. gage pressure 28 expansions are available, and the relative values of a pound of steam in the two cases are 3.99 and 4.33, an important gain of 8½%. in economy. How much the condensation would be increased by the greater range of temperature I am unable to state, as it follows no established law. In the case of the higher pressure the reheating reciver becomes more efficient. In general, in seeking to economize, there is more to work upon in diminishing condensation, because condensation in cylinders is so large, amounting to as much as 50% of the steam entering the engine in cases. In the Leavitt engine at Lawrence, economical as it was, the condensation amounted to 40% of the steam entering the cylinders. The use of the jacket in preventing condensation is well established. In many cases the saving from its use has been considerably over 10%, but in some other cases it is much less, as, for instance, in the Pawtucket engine it was from 2 to 3%. Its action is somewhat mysterious, and it cannot be predicated in any case what the saving

will be. It is undoubtedly quite essential in the use of the higher pressures.

We have so far confined our attention to the steam end of the engine, but there is some opportunity to economize at the pump end. The amount of power in pumping engines absorbed by friction of machinery and water is in general 8 or 9%, but it has occasionally been as little as 5%, and in the case of the Worthington high duty engine at Lowell was found to be only 2.8%. All that can be done to minimize this friction is to send as little work from the steam end to the pump end through intermediate machinery as possible, and in this respect a direct-acting pump will probably always lead, although it may be questionable whether the compensating apparatus in the high-duty direct-acting engine may not absorb as much power as the connections and shaft in the flywheel engine. Considering the small total friction of the Pawtucket engine, and of the Newton engine in the first test, and of several direct-acting engines, this point may well be raised. Other points to be attended to are a reduction of the suction lift, so that the pump will promptly and well fill; ample suction and discharge valve areas, ample passages and easy turns assist in diminishing friction. Reduction of suction lift is best effected by vertical pumping engines. Experience indicates that if the areas through valves and water passages are sufficient to give a water velocity of 250 ft. per minute, or less, they are ample. The water through the valves should be carefully guided and not too abruptly deflected. Efforts should be made to reduce shocks in pumps, for when they exist, more or less energy is wasted. This can be accomplished by small lift and quick-seating valves, but the most perfect means of accomplishing this is by the mechanically closed valves devised by Professor Riedler, of Berlin. This consists of an apparatus which allows the valves to lift by the water pressure, but closes them by mechanical means before a return current has time to form. It is said that by this means pumps can be run at almost any speed without shock. It is hoped that within a year the new Leavitt engine at the Boston water-works will furnish us with an object lesson in this respect. (See Eng. News, Dec. 22, 1892).

I do not wish to imply that the ordinary multiple automatic valve pump cannot be run fast. The Pawtucket pumping engine shows that it can with success for years, and there is a flywheel pumping engine at Toronto, designed by the Geo. F. Blake Manufacturing Co., that has for several years been running from 60 to 80 revolutions per minute. It consists of a Brown cross-compound engine, with piston rods passing through the back cylinder heads into Blake pumps with large valve area. The pumps receive water under pressure, and they work with perfect quiet. It is a significant fact in this connection that many pumping engines which have been speeded up have run best at the highest speeds, specially if they have low suction lift and large valve area. This is undoubtedly due to the high velocity of the water and the proportionate inability to form a return current by a reversal of the plunger movement, and thus a slower seating of the suction valves and resultant reduction of shock. It is conceivable that a pump might run so fast that the current of water would move forward so rapidly that reversal would not occur, and that there could not be a shock. In that case the suction valves would be slow in seating and seat by the pressure of the springs upon them.

The plunger speed of pumping engines is often, and in fact generally, limited to a certain number of feet per minute, without regard to the number of strokes made by the engine. There is widespread misapprehension on this point. The requirement mentioned is imposed in order to diminish shocks, but as the shock occurs at the instant of the reversal of the plunger, it is evident that a limitation of reversals should be made. If the reversal has been made and the shock has occurred, it is evident that the water can be moved with unlimited speed with safety. Engines are often built to make a certain number of revolutions per minute, and are so designed that the plungers have a shorter stroke than the steam pistons in order to diminish the plunger speed. Such an arrangement can accomplish nothing, for the same amount of water must be displaced at each stroke whether the pump stroke is long or short, necessitating the same amount of valve area, the same acceleration and retardation of water, and often inconvenience in construction. With the shorter stroke the plunger diameter must be increased, and in many designs this requires an undesirable diameter of pump in order to secure sufficient valve area.

The superintendent of water-works is often required to select between vertical and horizontal pumping engines. I trust that the time will come when no horizontal pumping engines will be made, for they are likely to be a source of great expense in repairs in consequence of wearing cylinders and pumps from the friction caused by the weight of the moving parts. In some cases pistons act like planing machines on the cylinder boxes, and leakage of steam and reduction of duty may result. The horizontal engine also requires more cylinder oil than the vertical, and the friction of the machine is greater in the former. It is notorious that the vertical engine for any service is more durable, reliable and economical than the horizontal.

Having considered pumping engines from various points of view, I wish to consider methods of testing. Within a few years a movement toward a rational system of testing pumping engines has occurred which culminated in the appointment of a committee by the American Society of Mechanical Engineers to devise and report upon a standard method of conducting and reporting such tests. For a number of years it has been common to separate the engine from the boiler by specifying duty per a certain number of pounds of steam used by the engine, as 1,000 lbs. As the engine does its work in virtue of heat carried to it, it is obviously better to specify duty in terms of a certain number of units of heats used by it and its necessary auxiliaries, such as reheaters, jackets and feed-pumps. The committee referred to reported in favor of this plan, and recommended the use of 1,000,000 British heat units or, in other words, that the duty shall be the number of foot-pounds of work done by the pump per 1,000,000 heat units absorbed by the engine. I propose to explain this in detail. When steam of a certain pressure, and, therefore, temperature, passes the throttle valve into the engine, each pound possesses a certain number of heat units, and knowing the number of pounds entering the engine by weighing the feed-water, it is an easy matter to compute the total amount of heat units that enter the engine in a given time. This steam passes out of the engine partly as steam and partly as water at a temperature lower than that at which it entered. The engine has, therefore, used a certain number of heat units in doing its work. The temperature at the end of the process is called the temperature of rejection, and is practically the temperature of the feed-water as it leaves the engine or any feed-water heater with which the engine is provided, for the cycle takes place between the engine and boiler. If there are jacket and reheater drains, their amounts and temperatures must be considered if it is practicable to return them to the boiler. It is obvious from this that the hotter the feed-water the less heat the engine uses, and the higher the duty will be. If independent feed pumps are used they must be considered a part of the engine, the steam used by them counted, and the temperature of the boiler feed if raised by these pumps must be taken for the temperature of rejection. If cold water is used for feed its temperature is the temperature of rejection. In such a test the initial pressure should be taken close to the engine, so that the engine shall not suffer from the condensation and wire-drawing which may come from a long pipe, for which it is in no way responsible, and the temperature of rejection shall be taken as near the engine as possible, so that it shall not suffer from a fall on account of a long feed pipe for which it is in no way responsible.

Now in regard to the foot-pounds of work done by the pump end, this should be determined by multiplying the pressure against which the plunger acts, including suction lift, by its area of cross-section and by the distance through which it moves. It will be observed that this method takes no account of the water pumped, for this can be determined by weir measurement or otherwise, and the contractor should be held as responsible for the capacity of the pump as for the duty. The quality of the steam near the engine should be determined in order to accurately compute the amount of heat passing into the engine.

The propriety of leaving the boiler out is evident. It may be a poor evaporator, a bad primer; it may have good or bad coal, it may be fired well or badly, or it may be dirty, and for any of these the engine is not responsible. In order to protect the purchaser the boiler should be put in under a guarantee to evaporate so much water, when reduced to the equivalent of feed at 212° and evaporation at that temperature per pound of combustible consumed.

In this connection I wish to refer to the need of a standard coal for testing boilers, and I think it would be well for this association to officially recommend the use of George's Creek Cumberland in lump form. This coal is recommended because it is easily procured, is good, and suffers less from exposure and transportation than some others. The lump form is recommended because it is nearer a standard state than fine coal, and is, therefore, a more definite thing. The boiler should not be held responsible for the incidents of transportation and exposure.

The duty of pumping engines is often greater on trials than in later service, but there are some exceptions, the Lynn and Lawrence engines being examples. If the coal used for heating and other service is deducted I should generally expect an increase of duty, for if the engine and boilers are not neglected, all parts must work better, and they are likely to be treated by more intelligence with an increase of experience.

Finally, I wish to draw your attention to the means of producing economy that are left to us. We must look to the steam end of our pumping engine for further improvement, as pump resistances are near a minimum at present. As before hinted, the greatest field is in preventing cylinder condensation, and while the triple expansion engine has done much when intelligently designed, it would seem that the quadruple engine is justifiable where coal is not cheap, and this with pressures easily and safely carried.

It would seem that the use of superheated steam offers the most promising field for the future in the prevention of condensation. In the past a durable superheater has not been produced, but at present I am of the opinion that it can be. The next difficulty is to furnish sufficiently high temperature waste gases for superheating from the boiler without injuring the boiler performance so as to counterbalance the gain from superheating. Recent experiments that I have made with boilers of the locomotive type burning from 16 to 70 lbs. of coal per sq. ft. of grate per hour show plainly that evaporations of over 13 lbs. of water from and at 212° per pound of combustible can be obtained when gases are escaping at 600° F. This is sufficient for considerable superheating, and such a boiler performance can be obtained with induced artificial draft. The remainder of the field for economy is chiefly to utilize all waste heat from the engine and boiler for heating feed-water.

In conclusion, I predict that the most economical steam plant of the future will be designed as follows:

The boiler will be of the locomotive type, having a ratio of heating to grate surface of 75 or 80 to 1, working with over 200 lbs. of steam, having artificial draft and burning 30 or 40 lbs. of coal per sq. ft. of grate per hour. This type of boiler is selected because it is the most economical of all boilers, either when forced or not, will stand the highest pressures, extreme forcing and general abuse without harm for many years. It is the pioneer of high pressures throughout the world, and its success under the most trying conditions shows it to be perfectly safe.

The engine used will be a moderately fast running vertical quadruple expansion furnished with steam superheated by the waste gases of the boiler. The cylinders will be steam jacketed, and the initial steam in the high pressure cylinder may be wire-drawn considerably below the boiler pressure. There will be reheaters between the cylinders, the condensation from the working steam side of which will be passed through evaporators in the smoke flue of the boiler and returned to the most advantageous point of the engine.

The live steam should not evaporate any of this condensation, on account of the great amount of heat required, but should merely prevent condensation. The condensation from the live steam side of the reheater should be returned to the boiler. There will be a feed-water heater in the low-pressure exhaust pipe and this water will have added to it the rejected heat of the auxiliary engines, if there are any, and will then pass through an economizer in the flue beyond the superheater and evaporator on its way to the boiler. The jacket condensation will pass to the boiler independently. The smokebox end of the boilers will be near the engine in order to diminish the dissipation of the superheat of the steam which occurs very readily.

In the case of pumping engines the pumps will have a large valve area with many small automatic valves or with few large automatic lifting and mechanical closing valves.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Liabilities of Directors of Water Companies.

Where the statute provides that the capital stock of a company shall be paid into the treasury within 18 months from the incorporation, and that if, by reason of the violation of any statute in relation to such company, it shall become insolvent, the directors ordering or assenting to such violation shall jointly and severally be liable for all debts contracted after the violation, and for the form of action against such directors. It is the duty of the directors to see that the capital stock is paid in as provided, and they cannot avoid liability for failure to do so by claiming that the treasurer failed to perform his duty. Clow v. Brown, Sup. Crt. of Ind., 33 N. E. Rep., 1,126.

Power to Construct Sewers.

The law specifies two methods in which authority may be obtained by a board of village commissioners to construct sewers: One by special election, to determine whether sewers shall be constructed according to a general system proposed by the board; and the other by laws of 1891, which provide that whenever a petition for the construction of a sewer, to be paid for by the land specially benefited, is presented, signed by the owners of at least 500 lin. ft. of land on any street through which a sewer is projected in the system, the board shall give notice of a time and place when they will hear persons for and against the construction of such portion of the system, and if, after hearing, the board shall determine to construct such portion, it shall proceed to enter into contracts therefor. The board cannot, on being asked to construct a sewer in a certain street, go beyond the prayer of the petition and extend the sewer into other streets. Drake v. Board of Sewer Commissioners, Sup. Crt. of N. Y., 23 N. Y. Supp., 264.

Repeal of Grant of Right of Way by Municipal Corporations.

A city which has by ordinance granted to a street railway company the right to lay tracks on one of its streets may revoke such grant by repealing such ordinance, even after the track has been laid, when, in the judgment of the city council, the public safety and convenience and the proper regulation and use of the street require it. Such repeal gives the railway company no claim for compensation, where the track was laid after it had notice that the mayor would recommend the passage of the repealing ordinance as soon as it could be done. Lake Roland El. Ry. Co. v. City of Baltimore, 26 At. Rep., 510.

Damages for Change of Grade in Streets.

The fact that a street is raised above the grade of an intersecting street, so that vehicles can no longer pass from one to the other at that point, does not entitle a property holders owning land adjoining, though separate, lots, on each street, to damages for the lots on the intersecting street, but only on the lots abutting on the changed grade. (Lawrence v. City of Philadelphia. Supr. Ct. of Penn., Feb. 13, 1893. 25 At. Rep., 1079.)

Adoption of Resolution for Laying Out Streets.

The statute relating to the laying out of streets in a city provides that the city council shall, within sixty days after the commissioners of estimate and assessment shall have made their report, elect whether they will make the improvement, and the city charter provides that, if an ordinance presented to the mayor for his signature is not returned by him to that branch of the city council in which it originated before the end of the meeting holden next after the lapse of ten days subsequent to the presentation of the bill to him, the same shall be a law in like manner as if he had signed it. Where a resolution to lay out a street was presented to the mayor for his approval two days before the expiration of the sixty days, and became operative by reason of his failure to return it before the lapse of the ten days, as provided by the charter, the election by the city council was not completed within sixty days, and the proceedings to lay out the street could not be sustained. (In re Canal and Charles Sts., Supr. Ct. of R. I., Jan. 7, 1893. 25 At. Rep., 9750.)

Provision for Repairs by Contractor in Street-Paving Contract.

A requirement in a street-paving contract that a contractor shall keep the street in repair for five years imposes an additional burden on the property owners, and therefore vitiates the assessment made under it, unless such assessment requirement is authorized by the statute providing for the letting of contracts for street improvements. The objection as to the additional burden is not removed by testimony of the contractor that the requirement did not enhance the amount of his bid, as others might have bid a less sum if the contract had not contained such requirement. (Brown v. Jenks. Supr. Ct. of Cal., 32 Pac. Rep., 701.)

Constitutional Limitations of Municipal Indebtedness.

Where improvement bonds of a city declare that it acknowledges itself indebted to, and promises to pay the bearer thereof the sum of ..... dollars, lawful money of the United States, and that they are payable out of the proceeds of the improvement assessments chargeable on the property benefited, and that they are issued on the faith and security of such assessment, the city is bound absolutely for the payment of such bonds, though it might be reimbursed from the payment of the improvement assessments, and that they constituted municipal indebtedness, within the meaning of the constitution prohibiting a municipality from incurring an indebtedness exceeding five per cent. of the value of the taxable property therein. (Fowler v. City of Superior. Supr. Ct. of Wis., 54 N. W. Rep., 800.)

Compensation for Vested Rights.

The question as to what is just compensation for private property taken for public use is a judicial and not a legislative question; and the provision in the act authorizing the condemnation of a lock and dam belonging to the Monongahela Navigation Company that, in estimating the sum to be paid by the United States, the franchise of such corporation to take tolls shall not be considered or estimated, does not preclude the court from giving compensation for such franchise. The only authority which the United States has to condemn a lock and dam belonging to a corporation chartered by a state is derived from the power to regulate interstate and foreign commerce, and such power must always be subject to the obligation imposed by the Fifth Amendment, to make just compensation for private property taken for public use. The power of Congress over waterways connected with the great rivers of the country is supreme whenever it chooses to exercise the same, but, before it has acted, the legislative power of the state within whose borders the stream flows is competent to charter a corporation to improve the same, and to give it a franchise to collect tolls. A franchise thus granted is a vested right, and, if Congress thereafter, by condemnation, takes such improvements, it is bound to make just compensation for the value of the franchise as well as for the physical property taken. The fact that Congress possesses supreme power does not cause a grant of such a franchise by the state to be a mere license which is revoked or annulled when Congress, in the subsequent exercise of such power, takes possession of the improvement. (Monongahela Navigation Company v. U. S. Supr. Ct. Rep., 622.)

CONSTRUCTION NEWS

RAILWAYS.

East of Chicago.—Existing Roads.

BALTIMORE & OHIO.—It is reported that the branch from Washington, Pa., to Waynesburg, Pa., will be located this fall, and that the line will eventually be extended into the coal and iron fields of West Virginia.

CHICAGO & EASTERN ILLINOIS.—A route was surveyed two years ago for an extension of this road through Mitchell, Ind., to Louisville, Ky., and the question of construction is again being discussed.

FITCHBURG.—A third and possibly a fourth track will be built between Boston and West Cambridge, Mass., according to reports.

NEW YORK CENTRAL.—The Gouverneur & Oswegatchie road has been completed and opended for traffic. It extends from Gouverneur to Edwards, St. Lawrence Co., N. Y., a distance of nearly 15 miles.

NORTH BEND & KETTLE CREEK.—This road is being built in Pennsylvania from North Bend to Stone House, near Cross Fork, Potter Co. Six miles of track have been laid and 7½ miles graded. The work is being done by the company under the supervision of Edward Hacket, Gleasontown, Pa. About 150 men are at work and 4¾ miles of road are in operation, carrying lumber, coal, etc. Passenger equipment will probably be added next summer. F. A. Blackwell, Pres. and Gen. Man., Gleasontown.

PARRY SOUND COLONIZATION.—It is expected that this road will be ready for passenger service between Ottawa and Eganville, Ont., by October. The grading has been completed between Arnprior and Renfrew, according to reports, and the iron is being placed in position in the bridge at Arnprior.

ST. MARY'S & SOUTHWESTERN.—The construction of this proposed railway between St. Mary's and Croyland station, all in Elk Co., Pa., has been commenced and will be pushed to rapid completion, it is said. B. Frank Hall, Pres., St. Mary's, Pa.

TIVOLI HOLLOW.—About 70 men and 20 teams are at work on this road, 1½ miles in length, near Albany, N. Y. Walter Melius, Engr.

WESTERN MARYLAND.—The completion of the Baltimore & Harrisburg extension between Porter's and York, Pa., a distance of about 14 miles, was celebrated July 27. Regular trains will be put on Sept. 1.

Projects and Surveys.

CAPE BRETON.—The surveying party of the Cape Breton Ry. Extension Co. is reported as within eight miles of Marion Bridge, which is about 12 miles from both Sydney and Louisburg. The preliminary survey is expected to be completed by the middle of this month.

EASTERN CENTRAL.—The preliminary survey has been completed from Galion, O., to the Ohio River and a route is now being selected between Galion and Kenton. R. H. Lee, Ch. Engr., Londonville, O.

LEHIGH & PAVILION.—The state board of railroad commissioners has granted permission for the construction of this proposed railway in New York from Lehigh, Genesee Co. to the town of Pavilion. Pres., Edward T. Fuller.

Southern.—Existing Roads.

MONTGOMERY, HAYNEVILLE & CAMDEN.—About 11 miles are now graded on this proposed road from Camden to Montgomery, Ala., a distance of 73 miles, and arrangements have been completed for grading nine miles more. C. P. Rogers, Ch. Engr., Camden, Ala.

SHERMAN, SHREVEPORT & SOUTHERN.—A mortgage of $3,100,000 has been given to provide funds for the proposed extension to Shreveport, La.

Projects and Surveys.

LOUISVILLE & JEFFERSONVILLE TERMINAL.—This company, which was recently incorporated by Dennis Long and others, has voted to consolidate with the Louisville & Jeffersonville Bridge Co.

Northwest—Existing Roads.

CHICAGO & NORTHWESTERN.—The extension of the Chicago, St. Paul, Minneapolis & Omaha road between Ponca and Newcastle, Neb., 14 miles, has been completed.

MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE.—It is reported that tracklaying is progressing at the rate of two to three miles a day on the extension of this road from Cathay, N. Dak., to the Canadian line. Regular train service between Minneapolis and Minot, N. Dak., was inaugurated July 31. The track has been laid to Foxholm, N. Dak., 120 miles from Cathay, the total distance of the extension being 181 miles.

Projects and Surveys.

RED RIVER VALLEY & WESTERN.—Incorporated in North Dakota to build a railway west from Addison, on the Great Northern; capital stock, $100,000. The contract for the first 12 miles is reported as awarded to Foley Bros. & Guthrie, St. Paul. Pres., Frank Lynch, Casselton, N. Dak.

Southwest.—Existing Roads.

AUSTIN & NORTHWESTERN.—Surveys are being made for an extension of this road from Marble Falls to Mason, Tex., a distance of 40 miles.

CHICAGO, ROCK ISLAND & PACIFIC.—The extension from Terral, Ind. T., to Fort Worth, Tex., has been opened for passenger traffic.

EL PASO & NORTHERN.—A meeting was called for the organization of this company under a new charter, to be held in El Paso, Tex., Aug. 10. The proposed road is from El Paso to White Oaks, 160 miles, of which the first ten miles were built in 1888, since which time nothing has been done on the road. In 1892 the road was purchased by the late Jay Gould. It is now proposed to repair the ten miles already constructed and to extend the road to White Oaks as soon as possible. An extension to Washburn, in the Panhandle district, is also proposed, thus giving a direct line from Central Mexico to St. Louis, by way of El Paso.

EXCELSIOR SPRINGS.—This road from Excelsior Springs, Mo., to Cooley's Lake, a distance of about ten miles, will be completed in about a month, according to reports. F. S. Mitchell, Ch. Engr., Excelsior Springs, Mo.

TEXARKANA & FORT SMITH.—A press report states that the Arkansas Construction Co., Kansas City, has been awarded the contract for building this road from Fort Smith, Ark., to Sabine Pass, Tex., less the 42 miles already built and in operation north of Texarkana, Ark.

Projects and Surveys.

AUSTIN, BASTROP & COLORADO VALLEY.—Surveys are being made for the construction of this proposed road from Austin to Bastrop, Tex., a distance of about 30 miles.

BALLINGER & ABILENE.—Incorporated in Texas to build a railway from Ballinger to Abilene, Tex., a distance of about 35 miles; capital stock, $2,000,000.

RIO GRANDE & NORTHERN.—The location survey has been about completed for this proposed railway in Texas between Van Horn and the San Carlos coal fields near the Rio Grande River, a distance of about 35 miles, and it is reported that the construction will be commenced in about two months. Pres., R. E. Russell, San Francisco, or Marfa, Tex.; Treas., Marshall Johnson, Pittsburg, Pa.; Secy., C. H. Murphy, Marfa, Tex.; Ch. Engr., G. N. Marshall, El Paso, Tex.

Rocky Mt. and Pacific—Existing Roads.

ASTORIA & PORTLAND.—According to press reports, the prospects are good for the early resumption of work on this line between Astoria and Portland, Ore. A contract has been drawn between W. H. Remington, Salt Lake City, and the Astoria Subsidy Guaranty Co., which stipulates that Mr. Remington must begin work on the railway within 90 days from July 6, and that he must do a certain amount of work every month from next October, and complete the line to a transcontinental connection by Oct. 15, 1894.

CANADIAN PACIFIC.—The construction of the Nakusp & Slocan railway from Nakusp, B. C., on Arrow Lake, to Slocan, on Lake Slocan, a distance of 21 miles, has been commenced by D. McGillvary & Co. The line will reach every producing mine in the district and will be completed by December next.

SAN PETE VALLEY.—This road is being extended from Moroni to Manti, Utah, a distance of 17 miles. The tracklaying will soon be commenced. Theo. Burback, Pres. and Gen. Man., Wales, Utah.

TACOMA, LAKE PARK & COLUMBIA RIVER.—Bonds for $500,000 have been sold and it is proposed to extend the road at once from Tacoma to Columbia River, Eastern Washington, by way of Cowlitz Pass.

STREET RAILWAYS.

AUBURN, ME.—The Lewiston & Auburn Horse R. R. Co. has contracted with the Auburn Electric Motor Co. to fit out a car with the storage battery system.

GARDNER, MASS.—The selectmen have granted a franchise to the Gardner Electric St. Ry. Co. to build a street railway 3¼ miles long between the several villages. M. A. Coolidge, Fitchburg, is reported as having the project in charge. J. W. Davis and L. A. Greenwood are interested; capital stock, $75,000.

HOLBROOK, MASS.—The Braintree St. Ry. Co. has been granted a franchise for an electric railway in this town, the construction to be commenced at Braintree village.

NATICK, MASS.—It is stated that work will soon be commenced on an extension of the Natick Electric Ry. from South Framington to Ashland and Hopkinton, the road to be completed to Ashland this year.

NEW LEBANON, N. Y.—It is reported that a company has been organized to build an electric railway from this place to State Line, Mass., baggage and freight as well as passengers to be carried.

PATERSON, N. J.—Maj. John Runk, Ch. Engr., Philadelphia, is surveying for a proposed electric railway about 40 miles in length from this city to New Brunswick, through Montclair, Bloomfield, the Oranges, Plainfield, Rahway and Metuchen, following the line of the Orange Mountains for 30 miles, and connecting with the various street railway lines in the towns along the route, also with the Pennsylvania, the Delaware, Lackawanna & Western and the Erie railways. It is reported that the storage battery or some other improved system of motive power will be used. The New Jersey Improvement Co. was recently incorporated to build the road. Pres. and Gen. Man., Jacob L. Stadelman, Bala, Pa.; Secy., John M. Bethel, Philadelphia; Treas., E. W. Smith, Morristown, N. J.

ECKLEY, PA.—Coxe Brothers & Co. have contracted for the construction of an electric railway 3½ miles long between this place and Buck Mountain, for the purpose of hauling stripping from Buck Mountain to Eckley for preparation.

NEW CASTLE, PA.—The Brinton Park Electric Ry. will soon be built to Big Run Falls, a distance of three miles.

WEST CHESTER, PA.—The Suburban Ry. Co. has been incorporated to build an electric railway in this place and to Kennett Square, Paoli, Glen Loch, Haverford, Overbrook and Philadelphia; capital stock, $400,000; W. J. Fell, R. C. Fulton, Philadelphia; Francis Fennimore, St. Davids; M. M. Child, Wilmington, Del.; W. S. Kirk, West Chester.

NEW ORLEANS, LA.—Sept. 5 the city will sell at public auction an extension for 50 years of the franchise now operated by the New Orleans City & Lake R. R. Co., any improved system of motive power except steam to be used.

McMINNVILLE, TENN.—A committee has been appointed to secure subscriptions for the proposed electric railway to Charles Creek. The electricity would probably be generated by water power.

SANDUSKY, O.—The completion of the Sandusky, Milan & Huron Electric R. R. is reported as assured. Equipment will be purchased at once, and cars are expected to be running to Norwalk this month. Thos. Wood, Supt.

SPRINGFIELD, O.—The county commissioners have granted a franchise to J. W. Neff and others for the proposed electric railway between this city and Xenia. The road is to be completed by June 1, 1895. Bids will be asked at once for the construction.

DUNKIRK, IND.—A. D. Ogborn has been granted a franchise for an electric street railway.

MUSCATINE, IA.—The Muscatine Electric Ry. Co. has been granted authority to make important extensions.

ATCHISON, KAN.—The Atchison Ry. & Electric Co. has been incorporated by Edward Morton, New York; A. J. Harwi, J. C. Fox and others of this city; capital stock, $250,000. It is reported that a franchise will probably be granted the new company at once.

ST. LOUIS, MO.—The St. Louis & Kirkwood Electric Ry. Co. has been incorporated to build an electric railway from Forest Park to Meramec Highlands, two miles southwest of Kirkwood; capital stock, $100,000. Dr. John Pittmann, G. D. Edwards and G. W. Taussig, Kirkwood, are among the directors.

SEATTLE, WASH.—A franchise has been granted to Guy C. Phinney.

SAN FRANCISCO, CAL.—The Pacific Underground Electric Ry. Co. has been incorporated by J. J. Scrivener, F. S. Chadbourne, J. F. Burgin and others; capital stock, $100,000.

VISALIA, CAL.—The Visalia R. R. Co. has been granted a franchise to extend its road. A $5,000 depot is reported as to be built.

HIGHWAYS.

NEW YORK.—A new highway is to be laid out in the town of Troupsburgh.

PENNSYLVANIA.—The citizens of Rutledge have voted to borrow $10,000 or $11,000 to construct telford roads.

VIRGINIA.—The commissioners of Alexandria county have about decided to grade the roads, make them a uniform width and then commence a system of macadamizing, according to reports.

BRIDGES.

BEL AIR, MD.—The commissioners of Hartford County will receive bids until Aug. 14 for the masonry for a bridge at Noble's Mill, Deer Creek. Chas. W. Proctor, Clk.

DAYTON, O.—Bids are asked until Aug. 28 for tearing down and removing a stone arch bridge; constructing an iron Pratt truss bridge, consisting of one span of 160 ft., with 24 ft. roadway and two 6-ft. sidewalks; and for constructing three iron hoist bridges, two to be 40 ft. clear span, with 50-ft. roadway and two 10-ft. walks, and one 95-ft. clear span with 38-ft. roadway and 8-ft. walks. C. A. Herbig, Cy. Comp.

TOLEDO, O.—Bids will soon be asked for a bridge in Western Ave.; estimated cost, $7,000.

EVANSVILLE, IND.—We are informed that the contract for the Franklin street bridge has been awarded to the Massilion Bridge Co., at $29,000. The bridge will be 170 ft. span and 60 ft. wide.

INDIANAPOLIS, IND.—The commissioners of Marion County will receive bids until Aug. 28 for a bridge over White River. Michael H. Farrell, Chn.

VELASCO, TEX.—The commissioners of Brazoria County want bids for four drawbridges.

WATER-WORKS.

WATERVILLE, ME.—The Kennebec Water Co. has been incorporated to increase the storage capacity of the Kennebec River. The company controls about 40 sq. miles of lakes, and will build dams and reservoirs; capital stock, $400,000; S. I. Abbott, Waterville; C. A. Dean, Winslow; J. M. Haynes, Augusta; E. J. Laurence, Shawmut, and others.

CLAREMONT, N. H.—The Claremont Water-Works Co. is reported as about to extend its system to Fairview.

LACONIA, N. H.—The county commissioners are receiving bids for a 50,000-gallon reservoir at the county farm.

MERIDETH, N. H.—The lowest bid for works, including cast iron pipe, reservoir and hydrants, is reported as $35,556. The bonds are about ready to be sold.

ATTLEBORO, MASS.—The town has authorized the commissioners to extend the system to South Attleboro.

NORTHAMPTON, MASS.—An additional supply is proposed from a stream south of Unquomonk Mountain.

QUINCY, MASS.—The commission has reported in favor of paying the Quincy Water Co. $515,640, with interest from April 30, 1892.

SAUNDERSVILLE, MASS.—A supply for fire and domestic purposes will be secured by the owners of the Saunders cotton mills, Messrs. Whitin, of Whitinsville, it is reported.

WEST SPRINGFIELD, MASS.—The town treasurer has been authorized to borrow $25,000 to secure an additional supply.

WEBSTER, MASS.—F. L. Fuller, Boston, is engineer of the proposed works. The contract for the stand-pipe is reported as awarded to the Cunningham Iron Mfg. Co., Boston.

PROVIDENCE, R. I.—Bids are asked until Aug. 31 for a pumping engine, as stated in our advertising columns. Robt. E. Smith, Comr. Pub. Wks.——The Roy Artesian Well Co. has submitted a proposition to supply the city with 15,000,000 gallons per day.

JAMESTOWN, N. Y.—At an election Aug. 3 the citizens voted in favor of the issue of bonds for $250,000 for works.

JEFFERSON, N. Y.—A gravity system is reported as being put in.

KINGSTON, N. Y.—It is reported that the aldermen have adopted a report recommending that a supply be secured from Esopus Creek, about 11 miles distant; estimated cost, $500,000.

PINE HILL, N. Y.—The Pine Hill Water Co. has been incorporated to secure a supply for both fire and domestic purposes; capital stock, $15,000; J. A. Longyear, J. A. Betts, F. W. Lament and others.

SOUTH AMBOY, N. J.—The citizens have voted on the question of works.

ALLEGHENY, PA.—There is talk of uniting with the city of Pittsburg to secure a supply. Several plans are proposed.

GREENCASTLE, PA.—We are informed that owing to the difficulties encountered in securing the right of way, etc., the question of works has been abandoned for the present.

McKEE'S ROCKS, PA.—We are informed that the proposed supply will be from artesian wells, and that bonds will probably be issued for $50,000. It is hoped to award contracts in October, the work to be done next year.

MEADVILLE, PA.—The fire and water committee has directed W. A. Doane, Cy. Engr., to prepare plans and estimates for municipal works. The Meadville Water Co. built works here in 1874.

MILLVALE, PA.—Bids are asked by the council until Aug. 14 for works.

THIBODEAUX, LA.—H. N. Coupon, Cy. Clk., informs us that the question of works will be decided Aug. 11; population, 3,900.

HARRIMAN, TENN.—Bids are asked until Sept. 1 for works, as stated in our advertising columns. A. W. Burr, Cy. Treas.

LANCASTER, KY.—The citizens are considering the question of works; population, 1,500; J. B. Kinnaird.

READING, PA.—The citizens have voted to construct a reservoir.

COLUMBIA CITY, IND.—Frank M. Douglas, Cy. Clk., informs us that at an election Aug. 1 the citizens voted in favor of works; estimated cost, $30,000 to $40,000. About seven miles of mains and 50 hydrants will be required. Alexander Potter, Engr., New York.

OVID, MICH.—Bids are asked until Sept. 4 for a tank to hold at least 2,000 barrels, to be upon a trestle at least 50 ft. high. W. E. Merrill, Chn. Com.

HARLEM (P. O., OAK PARK), ILL.—Bids are asked until Aug. 22 for furnishing and laying the following cast iron pipe: 16-in., 435 ft.; 12-in., 1,350 ft.; 8-in., 5,720 ft.; 6-in., 9,375 ft.; 4-in., 28,200 ft.; also for 100 hydrants, etc. Henry C. Meier, Vil. Clk.

SOUTH MILWAUKEE, WIS.—It is reported that extensions will be made at once; estimated cost, $10,000.

EASTON, MINN.—It is reported that a contract has been awarded for works.

ZUMBROTA, MINN.—W. W. Kinne, Cy. Recorder, informs us that the city contemplates building a water-tower or tank and laying several blocks of additional mains.

ATCHISON, KAN.—The Tucson Water, Electric Light & Power Co., of this city and Tucson, Ariz., has been incorporated; capital stock, $50,000.

HELENA, MONT.—The Bed Rock Water Co. has been incorporated; capital stock, $4,000.

CLINTON, MO.—The works of the Clinton Water Co. have been purchased by W. A. Foote, of this city, for Eastern bondholders. It is reported that improvements will be made.

ST. LOUIS, MO.—The board of public improvements will receive bids until Aug. 22 for 6,000 tons of pipe, castings, etc.

QUANAH, TEX.—W. D. Wagner, Secy., informs us that works will soon be put in; population, 2,500. J. W. Golston, Chn. Bd.

WAXAHACHIE, TEX.—We are informed that the Waxahachie Water Supply Co. will probably award contracts this month for an artesian supply; population about 4,000. Address W. C. Walton, Rome, Ga.

DENVER, COLO.—The Maroon Water, Light & Power Co. has been incorporated by E. F. Lamb, S. G. Collins and others; capital stock, $250,000.

SILVER PLUME, COLO.—The citizens have voted to issue bonds for works.

WALLA WALLA, WASH.—The city has voted, 793 to 245, to issue bonds for $160,000 for a gravity system of works. Works were built here in 1865 by the Walla Walla Water Co., and it is claimed that the present contract with the city has 19 years yet to run.

COTTAGE GROVE, ORE.—The citizens have voted to issue bonds for $5,000 for water-works and an electric light plant.

MOUNT TABOR, ORE.—The Mount Tabor Water Co. has been organized by C. F. Swigert, J. M. Arthur, J. H. Smith and others, to supply water, light and power in this village; capital stock, $15,000.

WEAVERVILLE, CAL.—The Weaverville Electric Co. has been incorporated to operate water-works, etc.; capital stock, $10,000.

WALLACE, IDAHO.—A. E. Angel, Cy. Clk., informs us that contracts will probably be awarded about Oct. 1 for works estimated to cost $20,000.

FAIRVILLE, N. B.—A special meeting has been called to consider the question of a supply.

SPRINGHILL, N. S.—A meeting has been called to consider the subject of works; estimated cost, $100,000.

ARTESIAN WELLS.

FINDLAY, O.—It is reported that the county commissioners will sink a well in the courthouse yard.

FRANKLIN, IND.—There is talk of sinking an artesian well, according to reports.

KENDALLVILLE, IND.—It is reported that four 6-in. wells will be sunk.

SEWERS.

BEVERLY, MASS.—The following bids were received for the proposed sewers: M. E. Gray, $18,650; Fitzgibbons & Peterson, $22,067; Welch & Bates, $38,930. As the bonds have not been sold all the bids were rejected.

HAVERHILL, MASS.—Plans have been prepared for an 18 to 30-in. sewer 3,276 ft. long; cut, 7 to 16 ft.

BUFFALO, N. Y.—Two brick sewers have been ordered; estimated cost, about $45,000.

MOUNT VERNON, N. Y.—Bids are asked until Aug. 22 for two lateral sewers. Elias G. Pease, Cy. Clk.

NEW YORK, N. Y.—Bids are asked until Aug. 16 for four contracts. M. T. Daly, Comr. Pub. Wks.——Bids are asked until Aug. 18 for four contracts. L. F. Haffen, Comr. St. Impvts., Wards 23 and 24.

ROCHESTER, N. Y.—Bids are asked until Aug. 21 for 17,700 lin. ft. of brick sewer, as stated in our advertising columns. The work includes 52,000 cu. yds. earth excavation, 20,300 cu. yds. rock excavation in trench and 1,800 cu. yds. in shafts and manholes, and 1,980 lin. ft. tunnel.

SCHENECTADY, N. Y.—A contract for 4,000 ft. 20-in. pipe sewer, including 275 ft. cast iron pipe, 2,000 ft. 18-in. and 400 ft. 8-in. has been awarded to John McDermott, at $6,701. Jas. Devine bid $8,157, and Jos. Clements, $9,248.

MEADVILLE, PA.—The council is considering extensions. W. A. Doane, Cy. Engr.

WASHINGTON, D. C.—The commissioners have ordered the constructing of several sewers.

DAYTON, O.—Bids are asked until Aug. 17 for 1,150 ft. 3½ ft. and 1,875 ft. 4½-ft. brick sewer and 320 ft. 24 to 15-in. pipe sewer. C. A. Herbig, Cy. Comp.

TIFFIN, O.—The city clerk has been directed to advertise for bids for several lateral sewers.

FORT WAYNE, IND.—Several 24 to 15-in. pipe sewers have been ordered by the council.

RICHMOND, IND.—The city engineer is preparing plans for a sewer over a mile in length.

SAGINAW, MICH.—Bids have been opened for $160,000 of sewer and street improvement bonds.

HARLEM (P. O., OAK PARK), ILL.—Bids are asked until Aug. 22 for brick and tile sewers. H. C. Meier, Vil. Clk. Robert E. Williams, Engr., 84 La Salle St., Chicago.

INDEPENDENCE, MO.—The city engineer has been directed to advertise for bids for a topographical map of the city.

ST. LOUIS, MO.—The board of public improvements will receive bids until Aug. 22 for seven contracts.

SNOHOMISH, WASH.—Plans for a system have been prepared by Stixrud & Nesbit, Seattle; total length, 9½ miles; estimated cost, $70,000.

STREETS.

GLOUCESTER, MASS.—The council has voted a loan of $6,000 to widen School and Main Sts., near Jordan's fish establishment.

SALEM, MASS.—The council is considering an appropriation of $24,000 for a new street to Peabody.

BUFFALO, N. Y.—The department of public works will receive bids until Aug. 21 for ten contracts for paving with asphalt, brick, Medina sandstone, etc.

HERKIMER, N. Y.—It is reported that the consent of property owners has been obtained for paving Mary St. with asphalt.

NEW YORK, N. Y.—Bids are asked until Aug. 16 for seven contracts for flagging, curbing, etc., and for 11 contracts for paving with asphalt. Michael T. Daly, Comr. Pub. Wks.

NORTH TONAWANDA, N. Y.—Bids are asked until Aug. 22 for paving Oliver St. with brick, as stated in our advertising columns. T. E. Warner, Vil. Clk.

PERTH AMBOY, N. J.—The estimates for the proposed paving of State St. are $3.50 to $4 per sq. yd. for stone, $2 to $2.30 for brick, or $1.30 to $1.75 for telford macadam.

ASHLEY, PA.—The council is selling bonds for $10,000 for the paving of Main St.

GREENSBURG, PA.—The council has voted to pave Park Ave., connecting North Maple and Walnut Sts., with brick; also to construct asphalt or flagstone sidewalks in two streets.

MEADVILLE, PA.—The council is considering the subject of additional paving. W. A. Doane, Cy. Engr.

PORTSMOUTH, VA.—Bids are asked until Aug. 14 for 150,000 paving brick, 2,400 lin. ft. stone curbing, etc. Jno. E. Owins, Chn. St. Com.

OCALA, FLA.—The citizens have voted to issue bonds for $25,000 to pave the streets with shells.

HAMILTON, O.—Bids are asked until Aug. 22 and Sept. 4 for street improvements. J. J. McMaken, Cy. Clk.

TIFFIN, O.—The city engineer has prepared plans for improving Clay, Madison and West Market Sts.

INDIANAPOLIS, IND.—Additional grading, gravelling and asphalt paving has been ordered.

MUNCIE, IND.—Bids are asked until Aug. 21 for improving three streets. F. A. Elrod, Cy. Clk.

DENVER, COLO.—The board of public works has over $700,000 of work in course of preparation, including the proposed paving of Broadway at an estimated cost of $150,753.

SEATTLE, WASH.—The city engineer has estimated that it will cost $17,545 to grade Pike St. between 8th and 12th Sts.

PORTLAND, ORE.—Plans are being made to pave 24 blocks of East Burnside St. with 5-in. plank. About 1,500,000 ft. of lumber will be required, including walks.

LOS ANGELES, CAL.—It is proposed to issue bonds for $500,000 for street, park and tunnel improvements.

ELECTRIC LIGHT AND POWER.

WEST TROY, N. Y.—Bids will be received at Watervliet Arsenal until Sept. 7 for an electric lighting and power plant. Maj. Isaac Arnold, Jr., U. S. A.

HARRIMAN, TENN.—Bids are asked until Sept. 1 for an electric light plant, as stated in our advertising columns. A. W. Burr, Cy. Treas.

JOLIET, ILL.—The bids received for an electric light plant at the penitentiary have all been rejected, and it is reported that new bids will be received without advertising. The bids were published in our issue of July 27.

DALLAS, TEX.—The Dallas Electric Co. has increased its capital stock from $400,000 to $600,000.

LAUNCESTON, TASMANIA.—The municipal council invites bids until Dec. 30 for lighting the city by electricity. Plans can be seen at the office of the Agent General for Tasmania, 5 Victoria street, London, S. W. C. W. Rocher, Tn. Clk.

NEW COMPANIES.—Brown Dynamo Electric Telephone Co., Moline, Ill.; $2,000,000; J. A. Brown, C. S. Brown, H. T. Moss.——Eureka Brick, Tile & Electric Co., Eureka, Ill.; $50,000; J. M. Deck, J. A. McGuire, W. E. Allen.——Western Electric Heating Co., St. Paul, Minn.; $1,000,000.

CONTRACT PRICES.

ASPHALT, BRICK AND GRANITE PAVING.—Philadelphia, Pa.—Contracts aggregating about $200,000 have been awarded, the prices ranging from $2.45 to $2.65 per sq. yd. for sheet asphalt, $2.16 to $2.40 for vitrified brick, and $3.49 to $3.75 for Belgian blocks.

EXCAVATION.—Boston, Mass.—The park commissioners received 12 bids for the grading of Wood Island Park, the prices ranging as follows: 27,000 cu. yds. loam excavation, 29 to 77 cts. per cu. yd.; 55,000 cu. yds. earth excavation, 35 to 84 cts.; 100 cu. yds. rock excavation, $1 to $3 (one bid of 25 cts.).

SEWERS.—Belfast, Me.—L. H. Murch, Cy. Clk., informs us that a contract for 1,840 lin. ft. 10 and 6-in. pipe sewer, average cut 6 ft., has been awarded to Chas. Baker, Belfast, at 30 cts. per lin. ft. for excavation and backfilling, $5.50 per cu. yd. for rock excavation, $75 for each manhole complete, and 50 cts. per lin. ft. for pipelaying; pipe to be furnished by the city.

JETTY.—San Francisco, Cal.—Lieut. Chas. L. Potter, in the absence of Colonel Benyaurd, has opened bids for the construction of a jetty at the entrance of San Diego harbor. It is stated that the rock and brush to be used cannot be procured nearer than 24 or 26 miles, and that most of the lumber will be procured in this city. The prices ranged as follows: Trestle, $5.17 to $11.50 per lin. ft.; mattress in place, $1.97 to $4.75 per cu. yd.; stone, $1.62½ to $3 per cu. yd.; office building, $500 to $800. The jetty will be 32 ft. wide over all, and a double-track, standard-gage railway will be constructed on the trestlework.

WATER MAIN.—Evanston, Ill.—Bids have been received for a 36-in. water main in Lincoln St., the

prices ranging as follows: Material,—36-in. cast iron pipe, 280 tons, $21 to $23; specials, 10 tons, $60 to $75; 36-in. horizontal valve, $406 to $500; 18-in. valve, $78.50 to $125; 14-in., 2, $48 to $68.92; all valves to be tested to stand a pressure of 250 lbs. per sq. in. Labor,—hauling pipe, 50 cts. to $1.25 per ton; laying pipe, $1.10 to $4 per lin. ft.; setting complete 36-in. valve, including valve chamber and hauling, $50 to $100; 18-in., $31.25 to $72; 14-in., $31.25 to $65; 12-in., $31.25 to $52; laying 12-in. pipe, 26 lin. ft., $1 to $3; 14-in., 26 lin. ft., $1 to $4.50; 18-in., 18 lin. ft., $1.20 to $6.50; labor and material for 9-in. pipe sewer, 200 lin. ft., 48 cts. to $1.35; work guaranteed to stand a pressure of 150 lbs. per sq. in. for one hour.

MISCELLANEOUS.

DAM WORK.—Manchester, N. H.—It is reported that the Hooksett Mfg. Co. will build an extension on the dam, construct a new canal, new head gates, etc.

Albany, N. Y.—Bids are asked until Aug. 14 for a stone dam across the Seneca River at Baldwinsville. Edward Hannan, Supt. Pub. Wks.——The contract for repairing the State dam at Cohoes has been awarded to Cunningham & Monty, Sandy Hill, at $83,389.

IRON WORK.—Louisville, Ky.—The Kentucky Heating Co. has awarded the contract for iron work for its new natural gas works to J. A. Holmboe, Engr., of this city.

NATURAL GAS COMPANY.—Huntington, W. Va.—W. E. Williams, Engr., writes us that a company is being formed there which will at once proceed to bore for oil and gas in Cabell County.

DRAINAGE CANAL.—Chicago, Ill.—The drainage trustees have voted to withdraw the contracts of McArthur Bros. for sections 2, 3 and 4 of the main drainage canal, and to readvertise the work.

PARK WORK.—Providence, R. I.—The park commissioners will receive bids until Aug. 17 for removing 15,000 cu. yds. of loam, sand or gravel in building the drives and grading grounds at Davis Park.

ENGINE, BOILERS, ETC.—Raleigh, N. C.—Bids are asked until Aug. 15 for a 40-HP. engine, two 85-HP. boilers, and a fan for ventilating building. John B. Burwell, Chn. Ex. Com., N. C. Insane Asylum.

DAMS AND SHORE PROTECTIONS.—Rock Island, Ill.—Bids will be received at the U. S. Engineer office until Aug. 24 for the construction of dams and shore protections between Quincy Bridge and Hannibal, Mo.

WOODEN ICE GUARD.—Cambridge, Mass.—Bids are asked until Aug. 18 for a wooden ice guard at Stony Brook, in Waltham and Weston; guard to be about 170 ft. long and built of oak piles and hard pine caps. L. M. Hastings, Cy. Engr.

ELECTRIC CRANES, ETC.—West Troy, N. Y.—Bids will be received at the Watervliet Arsenal until Sept. 7 for a 30 and a 60-gross ton electric traveling crane, a 2 and a 5-HP. electric motor, and 300,000 lbs. gun scale. Maj. Isaac Arnold, Jr.

DREDGING.—Albany, N. Y.—Bids are asked until Aug. 14 for dredging 70,000 cu. yds. from the Albany Basin, 15,000 cu. yds. from the west channel of Hudson River, at Coxsackie, and 22,500 cu. yds. from the east channel of the Hudson River at Stuyvesant. Edward Hannan, Supt. Pub. Wks.

ELEVATOR.—St. Paul, Minn.—The railroad and warehouse commission has received the following bids for the new state elevator at Duluth: Butler Bros., $269,000; Heidenrich Co., Chicago, $242,000; Metcalf-McDonald Co., $239,000; J. T. Moulton & Son, Chicago, $237,000; T. H. O'Neill, St. Louis, $198,700; Barnett-Record Co., Minneapolis, $229,500; Honstain Bros., Minneapolis, $238,000.

INDUSTRIAL NOTES.

LOCOMOTIVES.—The Richmond Locomotive Works, Richmond, Va., has a contract for six 8-wheel passenger locomotives for the Central of Georgia.

The Baldwin Locomotive Works, Philadelphia, has a contract for 30 locomotives for the Missouri Pacific.

CARS.—The Wason Mfg. Co., Springfield, Mass., has built 35 passenger cars for the New York, Lake Erie & Western to be used on the special World's Fair trains. They are duplicates of 50 cars built last year for the same company.

The Gilbert Car Works, Troy, N. Y., have delivered 20 passenger cars for the Lake Ave. elevated road, Chicago.

The Lackawanna Refrigerator Transit Co., Kansas City, Mo., is awarding contracts for 1,000 beef refrigerator cars, delivery to commence next month.

THE VULCAN IRON WORKS, Chicago, have two of their largest sized steam pile hammers at work on the foundations of the new stock exchange building, corner Washington and Lasalle Sts., and one on the foundations of the new public library, Michigan Ave. and Washington St., in Chicago. In the former, their present style shows marked superiority over the earlier form.

ROAD ROLLERS.—On the Chickamauga & Chattanooga National Military Park road two Pope rollers are used, one of 6 tons and one of 3½ tons. The engineer in charge, Mr. A. Thompson, writes very favorably of these rollers and says that they are not only used with ease on steep grades, but that they frequently develop soft places in the road which would otherwise not have been discovered until the regular traffic had developed them. In running over these places the roller sometimes gets stuck, but upon reversing the tongue and using some judgment the roller can in a very few minutes be taken out of the soft place. In this respect the engineer considers that this roller excels any other he has ever seen used. These rollers are manufactured by R. C. Pope, of Chicago, Ill.

NEW COMPANIES.—Whittaker Cement Co., Phillipsburg, Pa.; $250,000; Pres. and Treas., Thos. D. Whittaker, Philadelphia; Gen. Man., T. H. Graham, Philadelphia; works at Bonneville will be increased from 250 to 800 bbls. daily capacity.——Empire Pressed Brick Co., Rochester, N. Y.; $50,000; J. C. Woodbury, E. J. Burke, W. D. Callister; plant located at Canandaigua.——Kewaunee Brick Co., Kewaunee, Wis.; $15,000; Albert Boettcher, J. M. Borgman.——J. A. Ware Construction Co., St. Louis, Mo.; $15,000; J. A. Ware, C. F. Schneider.——Denver & Bermudez Asphalt Co., Denver, Colo.; $100,000; E. F. Lamb, O. E. C. Ginlich, S. G. Collins.——Osborne-McMillan Elevator Co., La Crosse, Wis.; $300,000; B. E. Edwards, Roswell Osborne, H. E. West.

SANITARY DISTRICT OF CHICAGO.
—TO CONTRACTORS.

Sealed proposals addressed to the Board of Trustees of the Sanitary District of Chicago and indorsed

"Proposal for Excavating a Portion of the Main Drainage Channel" will be received by the Clerk of the said Sanitary District at Room H, Rialto Building, Chicago, Ill., until 12 m. (standard time) of Wednesday, the 4th day of October, 1893, and will be publicly opened by the said Board of Trustees at the regular meeting held that day or at a special meeting called for that purpose.

The work for which the said tenders are invited is the excavation of that portion of the main drainage channel for the said Sanitary District, between Willow Springs and Joliet, Ill., known as contract sections two (2), three (3) and four (4), and consists in all of about 1,484,800 cubic yards of rock, of about 2,179,500 cubic yards of earth, the building of about 76,466 cubic yards of dry rubble walls.

Each of said sections will be treated as a separate contract in canvassing the proposals and making awards. As all awards will be made by individual sections, each bidder must make prices for each section separate and distinct from every other.

Each proposal must be accompanied by a certified check or cash to an amount equal to $3,000, multiplied by the number of sections bid upon.

All certified checks must be drawn on some responsible bank doing business in the city of Chicago, and be made payable to the order of the Clerk of the Sanitary District of Chicago. Said amount of $3,000 for each section will be held by the Sanitary District until all of said proposals have been canvassed and contracts awarded and signed, the return of said check or cash being conditioned upon any bidder to whom an award of any portion of said work may be made appearing within ten days after notice of such award being given, with bondsmen, and executing a contract with the Sanitary District for the section or sections of said work so awarded, and giving a bond satisfactory to said Board of Trustees for the fulfillment of the same in the amount of $100,000 for each section of work awarded him.

All proposals must be made upon blank forms furnished by the Sanitary District and must give the price for each separate item of work.

The bids will be compared on the basis of the engineer's approximate estimate of quantities, which will be furnished with copies of the specifications.

No proposal will be considered unless the party making it shall furnish evidence satisfactory to the Board of Trustees of his ability to do the work, and that he has the necessary pecuniary resources to fulfill the conditions of the contract, provided such contract shall be awarded him.

Bidders are required to state in their proposals their individual names and places of residence in full.

Specifications and plans may be seen at the office of the Chief Engineer, Rialto Building, Chicago, Ill.

The said Board of Trustees reserves the right to reject any and all bids.

THE SANITARY DISTRICT OF CHICAGO,
By FRANK WENTER,
President of its Board of Trustees.
Attest: THOMAS F. JUDGE, Clerk.
Chicago, Ill., Aug. 5, 1893. 32-8t

NOTICE TO SEWER CONTRACTORS

Sealed bids for building a trunk sewer, in the 10th, 15th and 20th wards of the City of Rochester, and the Town of Gates, Monroe County, N. Y., in accordance with the form of contract and specifications to be furnished by the Commissioners of Sewerage for the 10th, 15th and 20th wards, in the City of Rochester and the Town of Gates, will be received by the said Commissioners at their office, 410 Ellwanger & Barry Building, Rochester, N. Y., until 12 o'clock m. of Monday, August 21st, 1893, and at that time and place the same will be publicly opened and read.

There will be 17,700 lineal feet of 5 ft. to 9 ft. 3 in. diameter brick sewer, including 1,980 lineal feet of tunnel.

No bid will be received and deposited unless accompanied by a properly certified check for the sum of ten thousand ($10,000) dollars.

A bond will be required for the faithful performance of the contract, in a sum equal to double the amount of the contract.

All bids must be made upon blank forms provided by the Commissioners.

Plans can be seen and specifications and form of contract can be obtained at the office of the Commissioners.

Bidders are expected to thoroughly examine the location and satisfy themselves as to the conditions and requirements of the proposed work.

The Commissioners reserve the right to reject any and all bids should they deem it advisable to do so.

The Commissioners reserve the right, at their option, to make payments in certificates of indebtedness, payable on or before Jan. 1, 1897, bearing interest at six (6) per cent. per annum, payable semi-annually, as provided for by Chapter 603, of the laws of 1892.

GEO. B. SWIKEHARD,
FRANK S. UPTON,
HORACE G. PIERCE,
As Commissioners of Sewerage for the 10th, 15th and 20th wards in the City of Rochester and the Town of Gates.
32-1t

NOTICE TO CONTRACTORS.
PIEDMONT, W.VA., WATER-WORKS.

Sealed proposals will be received by the corporation of Piedmont, W. Va., until noon Aug. 21st, 1893, for furnishing all material and doing all labor necessary for the construction of a complete system of waterworks for the town.

The work to be done includes the contruction of and supply of:

(1) A brick pumping station, including intake dam and suction well.

(2) Two "Duplex" pumping engines, capacity 750,000 gals. each.

(3) Two 70-HP. horizontal tubular boilers.

(4) Service reservoir, capacity 1,050,000 gallons, including gatehouse.

(5) 412 tons of cast iron pipes, 4 in., 6 in. and 10 in.

(6) 5 tons of special castings.

(7) 30 hydrants.

(8) 24 valves.

(9) The laying of 4½ miles of mains.

Bids will be received for the above work in whole or in part.

Plans and specifications can be seen and blank forms obtained at the Town Hall, Piedmont, W. Va., or at the office of the engineer, No. 137 Broadway, New York, on and after Aug. 3d, 1893.

The Town Council reserve the right to reject any or all bids and accept any that may, in their judgment, be for the best interest of the town.

Certified check for $250 must accompany each bid.

Bids must be addressed to J. H. Bell, Recorder, Piedmont, W. Va.

J. W. W. DAVIS, Mayor.
J. H. BELL, Recorder.
ALEXANDER POTTER, Designing Engineer. 30-4t

DEPARTMENT OF PUBLIC WORKS.

Commissioner's Office,
Room 6, 31 Chambers Street,
New York, July 22, 1893.

The attention of contractors is called to the advertisement in the "City Record" inviting bids for the construction of a bridge over the Harlem River on the line of Third Avenue, between 129th and 135th Streets.

MICHAEL T. DALY,
Commissioner of Public Works.
32-3t

NOTICE TO LEVEE CONTRACTORS.

Sealed proposals will be received by the undersigned of the City of White Hall, Ill., until 2 p. m. of Sept. 1, 1893, for the construction of about 2 miles of levee near this city, altogether about 45,000 cu. yds., to be let in sections or as a whole. The right to reject any or all bids is reserved. For specifications and information address

32-3t LOUIS LOWENSTEIN.

PROPOSALS FOR CONSTRUCTION OF DAMS AND SHORE PROTECTIONS ON UPPER MISSISSIPPI RIVER.—U. S. Engineer Office, Rock Island, Ill., August 4, 1893.—Sealed proposals will be received at this office until two o'clock p. m. on the 24th day of August, 1893, and then publicly opened, for construction of dams and shore protections between Quincy Bridge and Hannibal, Mo. Specifications, blank forms and all available information will be furnished on application to this office.
32-2t

PROPOSALS FOR MAP-MAKING.

Sealed proposals will be received by the City Council of the City of Independence, Missouri, until 5 o'clock p. m. September the 1st, 1893, for a complete topographical map of the city; scale to be 100 feet to the inch and 5-foot contours; the city embraces about four square miles; map to be constructed on good muslin-backed paper; contractors are required to furnish all material and do all work necessary to complete the same; the Council reserves the right to reject any or all bids; for information in regard to the above work address H. H. PENDLETON, City Engineer. 32-1t

U. S. ENGINEER OFFICE, 34 West Congress St., Detroit, Mich., July 29, 1893.—Sealed proposals for (A) centrifugal pumps; (B) the driving machinery; and (C) the Babcock & Wilcox boilers for pumping plant for St. Mary's Falls Canal, will be received at this office until 2 p. m. September 27, 1893, and then publicly opened. Specifications, blank forms and all available information will be furnished on application to this office. O. M. POE, Col. Corps of Engineers, etc. 31-4t